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ABSTRACT

The Superhighways Teams Across Rural Schools (STARS) program sought to demonstrate how pupil learning and teacher professional development might be enhanced by the use of multimedia resources made available over communications networks. Subsidiary goals included developing strategies to support isolated gifted students through collaborative work, encouraging problem solving and creative and critical thinking through distance learning, exploring how a network using existing technology might be developed, and providing staff development for teacher engagement in network learning. The program ran from March 1996 to January 1997, and involved 127 students, most of whom were gifted, from 18 primary and 2 secondary rural schools in northern Scotland. Specific students gains included improved collaborative learning skills, particularly involving peers from other schools; increased problem-solving ability; high levels of motivation and task involvement; and enhanced self-evaluation skills. Gifted children showed improvements in problem solving, logical thinking skills, adopting special roles as leaders and coordinators, and taking responsibility for their own learning. Teachers showed gains in information and communication technologies and in teaching aspects of the classroom learning environment, with several noting fresh professional interests. Additional development opportunities both in and out of school were identified in regard to the teaching curriculum, approaches to learning, and the professional development of teachers. After an initial introductory chapter, this report contains chapters on learning and teaching strategies, underlying theory about teaching and learning through thinking, analysis of outcomes, funding and project promotion, presentations and reports, wider applications and opportunities, and conclusions. Contains 20 tables and 54 references. (Author/TD)

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J. M. Ewing

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STARS

SUPERHIGHWAY TEAMS ACROSS RURAL SCHOOLS

NORTHERN COLLEGE

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STARS
Report

on

Superhighway Teams Across Rural Schools Project

Jim Ewing
Jennie Dowling
Norman Coutts

1997

Northern College Dundee and Aberdeen

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This report is the record of the work undertaken during the STARS Project from its selection as one of the projects for inclusion in the UK Education Departments Superhighways Initiative (EDSI) in November 1995, through to the analysis of the data collected, completed in September 1997.

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They are:

members of each educational authority whose schools participated, for their identification of the schools, help in ensuring that each school then had the appropriate technical equipment, and assistance with funding for staff to attend the teachers' Seminar,

members of education authority staff and college lecturers who voluntarily gave many hours of their time in devising and revising the learning tasks,

technical and support staff from the education authorities and from Northern College who prepared technical manuals for software application and who dealt with and solved every technical difficulty experienced by the teachers in the project schools,

the external evaluators from the Scottish Council for Research in Education and the Scottish Council for Educational Technology for their open sharing of all their findings and their valuable suggestions for keeping the project on track,

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Rob Grant, seconded to Northern College from October 1996 to June 1997 to work on a number of computer related tasks, for his valuable expertise, unstinting industry, and consistent willingness to tackle every issue with commitment and enthusiasm,

most of all, the pupils and teachers in all the project schools, for their immensely committed approach, enthusiasm, interest and vitality. They were undoubtedly the true "STARS".

Executive Summary

The STARS Project (Superhighways Teams Across Rural Schools), set out to demonstrate how pupil learning and teacher professional development might be enhanced by the use of network technologies. The focuses were on teaching thinking skills and collaborative learning through problem solving with pupils in rural Primary and Secondary schools in Northern Scotland. The provision made was primarily for able pupils but a wider range of ability was included.

Eighteen Primary schools and two Secondary schools took part in the project, involving 127 children in total. Participation in the learning tasks ran from March 1996 to January 1997.

The network link between the schools was provided using FirstClass which has both a Conference and a chat facility. The management of the learning environment was handled by a team from Northern College in Dundee and Aberdeen and members of the educational staff from the Education Authorities involved.

The learning gains of the pupils often spread beyond those participating in the Project, such as an improvement in "overall IT competence throughout the school". Specific gains shown by the pupils included improved collaborative learning skills particularly involving peers from other schools; increased problem solving ability; high levels of motivation and task involvement; and enhanced self evaluation skills. Able children showed improvements in problem solving, logical thinking skills, adopting special roles as leaders and co-ordinators, and taking more responsibility for their own learning.

The teacher gains covered both the ICT and teaching aspects of the classroom learning environment with several noting a fresh professional interest in teaching thinking, differentiation and distance learning.

Further development opportunities both in and out of school were identified in regard to the teaching curriculum, approaches to learning and the professional development of teachers.

1 Introduction

1.1 Background

Superhighway Teams Across Rural Schools (STARS) was a project led by Northern College within the UK Education Departments' Superhighways Initiative (EDSI). This initiative set out to explore the potential of computer and communication networks (the Information Superhighway) in support of learning. The STARS Project was set up to investigate how the superhighway might bring new learning opportunities to pupils in remote rural schools, with a special focus on able children.

The co-directors of STARS were Jim Ewing, Jennie Dowling and Norman Coutts from Northern College.

The announcement of the selection of the STARS Project for inclusion in the evaluation programme of the Education Departments' Superhighways Initiative was made on 13 November 1995 and the project actually began in January 1996. The initial plan was for the STARS Project to run for one year.

This was one of two projects in the Scottish Superhighways Evaluation and involved a consortium of Northern College; several Education Authorities in the north of Scotland; NCTV Production and Facilities, a division of commercial video company AVC Enterprises Limited; and Grampian Enterprise.

Inclusion in the EDSI programme meant that the Project was subject to external evaluation but not funding from the Scottish Office Education and Industry Department (SOEID). The evaluation was managed by the Scottish Council for Educational Technology (SCET) and carried out by the Scottish Council for Research in Education (SCRE) during the period from January 1996 to March 1997.

The funding for the evaluation was provided by the SOEID and Dr Bridget Somekh led the evaluation a team of John Hall and Joanna McPake (both SCRE) and Bob Munro (of Jordanhill

Campus, University of Strathclyde).

The intentions of the independent evaluation of STARS were to

- assess the added value from using technologies in teaching and learning
- identify the services and applications of the technologies providing the greatest benefit
- recommend future directions for industry and education for successful implementation of information and communication technologies.

The techniques planned for use within the independent evaluation were to combine quantitative with qualitative approaches to provide information about what hardware and software were involved, how much it was being used and what it cost as well as information about teaching and learning in the classroom, classroom management and staff development.

The outcomes of the evaluation carried out by researchers from SCRE have been included in the Final Report on the EDSI Project, 'Preparing for the Information Age, Synoptic Report of the Education Departments Superhighways Initiative' (DfEE, 1997a) written by Peter Scrimshaw of the Centre for Language and Communications, School of Education, Open University. They are also mentioned in the Government's Consultation Paper, 'Connecting the Learning Society, National Grid for Learning', (DfEE, 1997b).

1.2 Rationale and Aims

The project was based on the rationale that a supported communication network could provide an enhanced environment for learning which is relatively independent of the location of those participating. The quality of such learning and the associated teaching and professional development of teachers, was seen as being influenced by the nature and form of the interactions supported by the network. Consequently a study of these interactions would be a prime focus for the project and was planned to include

- peer interaction between learners of similar ability
- interaction between learners and expert tutors
- learner interaction with materials, resources and facilities available through information and communications technology (ICT)
- teacher interaction with other staff for self help and professional development.

The overall aim of the project was

- to demonstrate how learning for pupils and professional development for teachers can be enhanced by the use of multimedia resources made available over existing and emerging communications networks.

The subsidiary aims of the study were identified as relating the specific areas of pupil learning, teacher professional development and the technologies, as follows,

- to develop strategies to support isolated able pupils through collaborative work
- to encourage problem solving, and creative and critical thinking through distance learning
- to explore how a network using existing technology might be developed
- to provide staff development for teacher engagement in network learning

The STARS Project was therefore designed to address the following issues,

- the influence on children's learning environment of the use of selected information and communication technologies, in terms learning gains, motivation and learning styles
- the management and effectiveness of an interactive learning environment involving remote contact and control
- aspects of learning associated with able children in remote locations
- the development of children's learning skills through the use of discussion and consultation at a distance
- the role of teacher mediation in distance learning for their pupils
- the development of ICT skills and attitudes of both pupils and teachers
- the professional development environment provided for staff
- the value of email and conferencing tools which allow teams of pupils to work together remotely
- the management of multimedia learning materials which can be accessed via the World Wide Web
- the conditions which influence realistic access for learning, to the World Wide Web and videoconferencing.
- possibilities for wider applicability of the materials and techniques used.

1.3 The Participants

At the start of the project, there were five Education Authorities in the north of Scotland willing to participate (Grampian, Tayside, Highland, Orkney and Shetland). After the reorganisation of local government regions on 1 April 1996 this number increased to eight (Angus, Perth and Kinross, Aberdeenshire, Highland, Moray, Orkney, Shetland and Western Isles).

1.3.1 The schools

The schools were selected for the project by the appropriate Education Authorities to meet the two general criteria,

- the presence of able children
- the schools were small and in relatively remote rural areas - small for Primary is a school with up to 4 teachers and for Secondary is with a role of less than 500 pupils; rural means a school located outwith a major town or city.

Initially only Primary schools were selected and the Authorities agreed among themselves to try to provide a range of schools from single teacher school up to those with larger numbers of teachers and pupils.

Eighteen schools were selected for participation although others were available to the project if required. Because the project was planned around the presentation of a pupil learning environment covering a full calendar year, there was some reluctance on behalf of the Project Directors to make changes to the cohort of schools initially chosen. However, at about the half way stage, the summer break of 1996, one of the Authorities did withdraw and consequently two schools stopped participating. At this point an Education Authority which had not been able to join at the beginning of the project, was included, adding a single further school to the group.

For the final two months of the project, two small rural Secondary schools were included and participated only in the aspects of the STARS Project associated with the World Wide Web.

Although the request to the Education Authorities was that all the schools should be small rural schools, there was a range of the number of pupils in the school. This is summarised for the Primary schools in Tables 1a and 1b.

school roll*	number of schools
up to 19 pupils	4
20 to 47 pupils	5
48 to 71 pupils	7
more than 71 pupils	2

Table 1a *Breakdown of school size by school roll.*

number of staff (full time equivalent)	number of schools
1	3
2	4
3	6
4 or more	5

Table 1b *Breakdown of school size by number of teachers.*

* categories in this column are based on figures from *The Staffing of Primary Schools , Circular 1029* (Scottish Education Department, 1978).

The two Secondary schools had rolls of 19 and 45 with 3 and 6 teachers respectively.

The full list of schools is given in Table 2.

Pierowall Junior High School, Westray, Orkney (withdrew in August 1996)
Orphir Primary School, Orphir, Orkney (withdrew in August 1996)
Careston Primary School, Careston, Brechin
Glenisla Primary School, Glenisla, Alyth
Stracathro Primary School, Stracathro, Brechin
Balbeggie Primary School, Balbeggie, Perth
Guildtown Primary School, Guildtown, Perth
Struan Primary School, Calvine
Happyhansel Primary School, Walls, Shetland
Skerries School, Out Skerries, Shetland
Carrbridge Primary School, Carrbridge
Sleat Primary School, Ardvasar, Isle of Skye
Newhall Primary School, Balblair, Conon Bridge
Kilmonivaig Primary School, Spean Bridge
Daviot Primary School, Daviot, Inverurie (unable to participate due to technical difficulties)
Glenlivet Primary School, Glenlivet, Ballindalloch, Banffshire
Hatton Primary School, Station Road, Hatton, Aberdeenshire
Crudie Primary School, Crudie, By Turriff, Aberdeenshire
Lionel Primary School, Ness, Isle of Lewis (from September 1996)
Newtyle Secondary School, Dunarn Street, Newtyle (from November 1996)
Kinlochbervie Secondary School, Kinlochbervie, Sutherland (from November 1996)

Table 2. *Schools participating in the STARS Project.*

Daviot Primary school was unable to overcome technical problems within the school to enable them to become linked with the FirstClass server at the Aberdeen campus of Northern College.

Because of some changes of classes at the summer break in 1996, the teachers taking part with their pupils in the STARS Project also changed over that period. Throughout the whole project, the number of teachers involved was three at the Secondary school level and twenty one at the Primary school level.

1.3.2 The pupils

Guidelines for the identification of able children were supplied to the Authorities and to the schools chosen by them. The guidelines were framed around the advice offered in a Report of HM Inspectors of Schools (HMI, 1993) which highlights several key beliefs or views on the able child and his identification in the classroom.

The information supplied was

1 There is no single definition of the able pupil which covers the full range of currently accepted indicators of high ability.

2 There is a widely held uncertainty or hesitancy in making judgements about able pupils, probably due to the imprecision or ambiguity of 'definitions'.

3 Exceptional ability in some creative and aesthetic areas is often recognised more readily than in other areas of schooling. Specific exceptions to this may lie in unusual achievement, for some children, in mathematics, science and technology.

4 There is a notion of 'good all-rounders', being those children who perform significantly above average in most or many areas of the curriculum.

5 In more precise terms teachers can normally identify more able pupils as those who quickly grasp ideas and who ask searching questions. It is likely that teachers will recognise that these pupils will think about concepts and ideas rather more than most pupils.

6 In some cases teachers will want to identify as able children, those who have best marks in tests and who are quickest to complete their work.

7 In addition there are those pupils who do not come into these categories, but about whom the teacher is convinced on the basis of intuition and experience, that there is an element of ability possibly unexposed because of the nature of existing classroom experiences.

From other sources, there are various lists of possible indicators or attributes of the able child. Some of the indicators which appear consistently in these lists are:

early achievement of basic skills such as numeracy and literacy
very much above average quality of work and rate of its completion
imaginative insights
ingenuity and resourcefulness
exceptionally high or low level of social skill
attention seeking behaviour
apparent boredom with regular classwork
originality in application of ideas or skills
logical thinking
leadership
curiosity
lots of own ideas and theories

Although the special aim of the project was to investigate how computer-based communication networks can challenge and support the learning environment of able pupils, the activities on offer could benefit all of the pupils in a class. Therefore within each school the pupils taking part in the project were identified by the teacher and could include others in addition to those identified as being the able pupils.

The total number of children taking part at some stage in the STARS Project, whether before the summer break in 1966 or after, or both ,was 127, of whom 116 were at the Primary level and 11 at Secondary. The distribution of the Primary school pupils across the stages in the school is shown in Table 3.

Class	P4	P5	P6	P7
Number of boys	3	6	18	29
Number of girls	6	9	10	35
Total number of pupils	9	15	28	64
Number of schools with pupils at this stage	5	7	10	14

Table 3 *Distribution of pupils in the STARS Project across stages in the Primary school.*

The distribution of the Primary school pupils was 56 boys and 60 girls, indicating very nearly an even divide. The eleven Secondary pupils were all in S1 or S2 and were also relatively evenly divided with 6 boys and 5 girls.

1.3.3 Information about the able pupils

To help provide background information about the able pupils participating in the project, each school supplied a confidential report on the relevant children, covering

- particular strengths which the child has (including intellectual, personal and social aspects as well as all others which seemed relevant)
- specific development needs which the child has
- special interests (including curricular and non curricular areas)
- relevant family influences (such as family size, position in family, family trends etc.)
- a brief 'pen picture' of the pupil as a learner including a selection of aspects such as solitary/co-operative; leader/follower; quick/slow worker; outward going/private; easy/difficult to motivate; neat/untidy worker; finisher/seldom completes a task; organised/chaotic; independent/dependent; patient/impatient etc.

1.4 Systems and Resources

STARS sets out to investigate how far Superhighway benefits can be delivered to remote rural areas using relatively inexpensive networks. Therefore, equipment requirements were designed to make little or no additional demands on schools or their Education Authorities in supplying additional hardware or software.

Participating schools had to be able to provide for the children involved in the project, regular access to an Apple 475 or IBM 486 computer (or better) and a 14.4KBS modem (or better) together with a suitable conventional telephone line.

Schools were all provided with the relevant software to use FirstClass, the registration costs being borne by the Project. Introductory manuals for using the MailBox and Conferencing facilities of FirstClass were also provided without charge. Staff from the existing Education Authorities provided the facilities to help the schools assemble and initiate the hardware and software systems in school.

Northern College was already a well established FirstClass conference site and the telephone connection to the FirstClass server was made available to all those taking part in the STARS Project at local call rates through the use of an 0345 telephone number.

The availability of systems beyond the basic requirement was surveyed in the early stages of the project to assist in the planning of the deployment of multimedia learning resources

throughout the project. This enabled the planned use of videotaped material to be selected in favour of Compact Discs. It was also clear that all schools had adequate computer printers to enable paper copies of computer images and texts to be used wherever it was felt appropriate to utilise this format.

1.5 Project Advisory Group

An Advisory Group was established to assist the project through establishing timeframe checkpoints for the submission of interim reports; to provide a base of expertise to support the project team and assist in the clarification of the project's aims; and to explore and promote a wider contact for the project particularly with regard to publicity and potential external support.

In addition it was expected that the Advisory Group could offer some assistance with commercial opportunities (such as in training and in videoconferencing) arising from the project.

The initial membership was:

Mr David Adams, Chairman
Mr Chris Burns, Headteacher of Glenlivet Primary School and 5-14 development officer for Grampian Region
Mr Hugh Macrae, Educational Development Officer for Perth and Kinross Council
Mr Alan Clark, Grampian Enterprise
Mr Keith Main, Director NCTV
Mr Neil Gordon, NCTV
Mr Peter Wakefield, Director, Centre for Rural Education, Northern College
Dr Jenny Tuson, Research and Development Department, Northern College
Mr Jim Ewing, Co-director of STARS
Mrs Jennie Dowling, Co-director of STARS
Mr Norman Coutts, Co-director of STARS

Also invited to attend meetings of the Advisory Group was Dr Bridget Somekh, Depute Director for SCRE, which has been subcontracted to carry out the evaluation of the STARS Project.

2 Learning and Teaching

2.1 The Learning Environment

The physical arrangements for working on the STARS tasks varied widely in the schools involved in the Project. In many schools, Primary as well as Secondary, the location of the computer which was used for the modem link to the Northern College FirstClass server, was outside the classroom. This was usually because that computer was largely intended for administrative use and was therefore located in the school office or the staffroom.

In other instances the work was split between that involved with receiving or sending messages and the problem solving or task related activities. The former might have to take place outside the classroom because of the position of the telephone access point, with the latter located in the classroom. Still other schools were able to allow all the work to be carried out within the locus of the classroom or possibly adjacent rooms such as those for general purpose or library use.

Of the eighteen schools involved in the STARS Project, both the Secondary schools and all but four of the Primary schools regularly involved groups of children where the total number was six or less. The arrangements for which pupils would participate in any one task was left entirely to the teachers in the school and in some schools there were several options available. With smaller classes often all children were involved all of the time, but in larger classes there might have been a division into groups. In certain schools these groups might undertake all the tasks, whereas in others there was an allocation of specified tasks to only some of the groups.

Because the thrust of the project was directed at able children, they were expected to tackle all the tasks and if there were to be more than a single group involved, the able children were often seen as part of the lead group.

The teachers made their own arrangements for the management of the learning environment for the STARS tasks. Depending on the age of the children and the demands of the tasks, there

was a varying amount of teacher input and support. Further details of how this changed as the project progressed are given below in sections 2.5.3 and 4.4.3.

Because of a range of significant differences in the project schools in terms of

- the pupils coming from different stages in the school
- ongoing projects or theme related work
- pupil experience of problem solving activities
- competing demands of curricular related learning activities
- varying focus on community activities (such as Christmas productions)

not all schools were able to fit in the STARS Project work as easily as others. Despite that, every school demonstrated a strongly positive approach to the creation of appropriate learning environments, with time set aside for the necessary pupil activities.

A common feature, however, of the varying arrangements for management of pupil learning was to give the pupils a significant measure of responsibility for their own learning.

2.2 Approaches to Learning

Two main aspects of children's learning were highlighted in the STARS Project. One was co-operative or collaborative learning within the classroom and in peer groups across several schools. The other was the critical and creative aspect of thinking in a problem solving learning context.

In addition, attention was given to the learning aspects of the professional development of teachers. This related to teachers' advancement in relation to information and communications technologies as well as the procedures and protocols which teachers might use for meeting the learning needs of able children in remote schools.

2.2.1 Co-operative and collaborative learning

The attention directed at co-operative or collaborative learning arose from the specific opportunities for pupil interaction in the learning environment provided by the FirstClass intranet used in the STARS Project. Opportunities for pupil co-operation with their peers in the classroom of a small rural school are clearly limited by small numbers. In many instances there may be only one or two pupils at a single stage (for instance Primary 5 or Primary 6).

Through providing a learning environment which moves beyond a single school to embrace a manageable number of additional schools with a similar social and educational background,

the STARS Project gave these pupils the opportunity to experience co-operative learning more meaningfully. There was the additional challenge of working with strangers whom the pupils could not see or speak to.

An attempt was made to reduce the impact of the lack of visibility and restricted contact for the children, initially only in the Primary schools. Two FirstClass conferences were set up for the pupils' use, one called 'STARS Pupils' and the other 'Starring Schools'.

In the Starring Schools conference, the pupils in the project were invited to exchange information about themselves, their school and their village or community. The project also provided them with a large map of Scotland so that they could locate all the other schools involved. Within a month of starting this conference, 11 schools had sent in descriptions and explanations of themselves, their schools and their localities.

Much later in the project, at the suggestion of both the pupils and the teachers, colour photographs of the children were collected and displayed on the STARS web page.

The STARS Pupils conference was intended to allow the pupils to exchange comments or notes or suggestions with others in the project. Most of them used it initially to say 'hello' although later it was also used to make arrangements for synchronous exchanges using the FirstClass chat facility. Nine of the schools had responded within a month of setting up this conference.

Using these two conferences to communicate with other pupils was, for most of the schools, the first time they had used FirstClass or any other electronic means to make exchanges using a computer and modem.

2.2.2 Critical and creative thinking

The selection of the critical and creative thinking focus arose from an early decision at the planning stage of the project to try to provide a stimulating learning environment for able children, managed electronically and at a distance from the school. The learning opportunities to be presented to these children were seen as supplementary to their ongoing class work.

As the project progressed it became clear that the work supplied was, for many, more than supplementary and often served as central to part of their current work in the classroom (particularly in Environmental Studies).

It was also expected that most schools would not already have identified critical and creative

thinking as part of the normal curriculum and that the STARS Project tasks could therefore make a useful addition to the whole learning experience of the small rural school.

This turned out to be the case for virtually everyone and no school appeared to feel that the work involved in the STARS tasks was an unacceptable repetition of other work of the classroom.

2.2.3 Teacher professional development

The project's attention to the professional development for teachers hinged in some measure on the efficacy of a network based structure for supporting the sharing of new information and the resolution of difficulties or misunderstandings.

Many of the teachers participating had only limited experience in using information and communication technologies. They were faced with tasks which demanded many new skills to be learned very quickly. As one teacher commented, "Our learning curve was very steep".

The technology related skills in using FirstClass were therefore new to most of the teachers and included downloading and uploading text and non-text files, using intranet conferences and sending electronic mail. In the later stages of the project some of the teachers chose to become involved, again for the first time for most of them, in using the World Wide Web.

The support for the teachers in these two areas was embraced by providing them with documentation some of which had been specially written, telephone support as often as required and online (using FirstClass) assistance with individual difficulties or problems. In addition, on site help was provided both by the Education Authority staff and Northern College technical support staff where necessary.

Further professional development was planned for the teachers in their exploration of the pedagogic issues associated with differentiated learning opportunities for able children in small rural schools. A guideline paper was passed to all the schools in the project as well as to relevant staff at Authority level. This was intended to provide an outline for further discussion about identifying such children as well as meeting their educational needs.

A FirstClass conference (STARS: Staffroom) was provided for teachers to exchange their views and comments on any matters which they felt appropriate. To help start this interchange, the information paper relating to the identification of able children was posted in this conference and a few suggestions were given about the issues relating to this. The project teachers were invited to respond and exchange views. Within the first two months after setting up this conference eight schools had posted items to it, none of which related to

the issues of able children. Identifying able pupils did not in itself pose the project teachers with major problems.

The later use of the STARS: Staffroom conference involved only one or two further schools and almost always related to matters raised by the project team, such as opting to be involved in World Wide Web activities. There was a short spell when several schools responded to a request for help from the project team with input for one of the tasks.

2.3 Format of the Learning Tasks

With the help of members of some of the Education Authority Advisor teams, the underlying approach to all of the learning tasks was selected as

- challenging (particularly for able children),
- related to the 5-14 curriculum but different from ongoing curricular work,
- focused on problem solving, but not restricted to mathematical problem solving
- providing opportunities for the specific thinking skills of critical and creative thinking

Initially the tasks were designed to be 'stand alone' so that schools could work through them at their own pace. This would enable the schools to become familiar with the procedures required for communication through FirstClass. Any problems or difficulties with the software, the hardware or the telephone based communications could therefore be attended to without interrupting the flow of the work for children in other schools.

It was planned that this should move into a more structured inter school collaboration stage where genuine co-operation between pupils in different schools would require them to tackle the same problems at the same time. To achieve this and to maintain a good level of motivation, the collaborative tasks were planned to be set in the context of a STARS Trek. As the pupils and the schools became very familiar with the STARS 'name' attached to all the work of the project up to the point, the progression to a STARS Trek seemed sustainable and appealing without being incredible.

Because the STARS Project ran during a single year (1996), it spanned two academic sessions. This meant a substantial summer break about the middle, with a change of some of the pupils from one academic year to the next, due to the promotion of the Primary 7 children to Secondary school. Neither of the two Secondary schools in the project took the

children from those Primary schools already involved There was therefore a restart of the Project after the summer holiday and at the request of the teachers, this began with stand alone tasks before rejoining the STARS Trek.

At a seminar for teachers and Education Authority staff involved in the STARS Project, decisions were taken about the possibilities of involving further resources for learning, in addition to FirstClass. The possibilities considered were the use of video conferencing and access to the World Wide Web as a medium for learning. The majority of teachers wanted these to be offered on an optional basis and preferably later rather than earlier in the project.

This was put into operation and a small number of schools chose to undertake additional work to the main STARS Project tasks within the last month of the planned timeframe of the project. Technical difficulties led to an abandonment of the trials with video conferencing (see section 4.5.3), but the World Wide Web activity was completed.

2.4 Preparation of the Learning Material

Within a few weeks of the project starting a learning materials work team was set up and began immediately to identify the programme of learning tasks to be used in the classroom. The team comprised the Project Directors, other members of Northern College staff and representatives from the Education Authorities Advisory staff. Following advice from the Education Authorities, classroom teachers from the rural schools in the project were not involved in the activities of the work team.

At a very early stage of the work of this group, a request was sent to 56 groups, companies or individuals involved in the production of school based learning software to identify what might be currently available in relation to critical and creative thinking skills in the Primary school. From 34 replies there turned out to be very little which could be used immediately with the FirstClass intranet system chosen for the STARS Project.

The work team therefore set out to identify and modify what existing material was available and to create new material where it was necessary to do so. This group remained active until about a month before the end of the project.

2.5 Support for Learning

There were several features of pupil learning which were identifiably different from what many teachers might normally have experienced. These included the focus on co-operative and collaborative learning; the identification of critical and creative thinking skills; problem solving tasks which were mainly located in curriculum areas other than mathematics; the use of communication technology as a learning medium; and the learning experiences associated with the involvement of other significant adults in the learning tasks.

The teachers in the project were in small schools, sometimes with no-one else to share professional concerns with on a frequent or regular basis. This meant that the teacher support which the STARS Project was able to offer, was of crucial importance to the project's success.

2.5.1 Support for the pupils

The support for the pupils appeared in several different formats. Within the context of each problem solving task as it was set, there were a few suggestions about the specific focus of thinking. In some instances this would focus on critical thinking and on other occasions the elaboration would be of creative thinking.

For example, the instructions for one of the earlier tasks included

> "Being critical in your thinking might include looking at **all** the information and deciding what **each part** contributes to finding the solution as well as considering all **possible** solutions and comparing them with the information given - how well do they **fit** the given information?"

A later task included the advice

> "Take account of all the factors which could influence the measure of bounce - don't stop at the most obvious ones, maybe some less obvious factors could make a difference. Perhaps you will have to be creative in your thinking at this stage as all your suggestions are at least worth considering."

Another form of support was to provide a response from the project team directly to pupils when they posted a suggestion or a solution to a STARS Task on the appropriate FirstClass conference. This was particularly important in the earlier stages of the project and particular efforts were made to achieve a 'rapid response' sometimes within an hour or so , although more usually within a day, sometimes two.

The teachers reported very positively on how this immediate feedback was highly supportive for the pupils,

"Feedback....was excellent and the children responded to the positive criticisms and words of encouragement".

Generally pupils were very willing to share their responses with the other children in the STARS schools and in this way there was a lot of supportive sharing of suggestions and ideas.

Due to the focus on critical and creative thinking, the tasks presented generally did not have single solutions. The pupils often found this a novel and challenging situation and the opportunities for sharing across schools was particularly supportive in terms getting a right answer. The pupils were clearly delighted to find that someone in another school had found the same solution and there were several occasions when they would comment positively about who they thought was right and who was wrong.

"Gordon thinks he has got he right answer and the rest of us all agree with him. Mairi from Sleat primary is very close to it. We're not going to say what our answer is yet."

The teachers commented that it was a revelation for some pupils to realise that not all problems have a right answer and that their peer group in other schools might come up with quite different solutions to the same task.

"(Tasks had).many possible answers. Some children took a longer time than others to accept this"

The many variables which influence schools working together, include

- differing demands within the classroom
- extra curricular activities (such as swimming which may involve a lengthy bus journey and several hours out of school)
- different ages of children working on the same problem
- varying levels of confidence and expertise in using information and communication technologies

These differences meant that the project leaders outside the school adopted a form of central support and control to keep track of the varying pace at which the work was progressing in all the schools. Sometimes this involved commenting to children about their own work and making suggestions to those who were responding well in advance of other schools. It also involved helping schools make contact with others in their group and encouraging those who responded more slowly than the norm, to try to keep them in step. In this sense the project team were highly 'visible' as a supporting element in the learning environment and the pupils very quickly got into the habit of addressing some of their comments directly to the project team (latterly referred to as 'Mission Control') using the MailBox facility on

FirstClass.

One other form of support was by the way of a summary at the end of each task, provided by the project leaders. This was an indication to all the participants how well they had followed the instructions or met the criteria of the task and it served to consolidate the learning of the aspect of critical and creative thinking selected for that task.

2.5.2 Groups for learning

Collaborative learning where the participants are widely separated is a form of distance learning. The establishment of groups within such learning environments is widely accepted as being supportive and there are many formats whereby co-operation and collaboration can be aided. The involvement of information and communications technologies adds a further dimension and an expansion of the means for supporting learning at all levels (see McConnell, 1994).

In the STARS Project the means selected for establishing groups for working together had a significant element of pupil choice and pupil identity. The groups were based in the context of the STARS Trek and used six roles as follows,

SCIENTISTS	like to think they know a lot, always ask questions, have a searching approach to critical thinking
NAVIGATORS	pilots of the future, like working out calculations, think they are very hard working
SPARKIES	believe in very practical solutions, like doing things, have a very detailed approach to their critical thinking
COUNSELLORS	think they are liked by everybody else, believe in the importance of people, like to talk
COMMUNICATORS	think accuracy is very important, want to be the historians of the future, think their contributions are the best
SPACE ANTHROPOLOGISTS	desperate to unravel the celestial secrets of other worlds, think they are very clever, good at creative thinking

The pupils in each of the project schools were invited to apply for one of the jobs, as a school, indicating briefly why they wanted their chosen post. A closing date for job applications was set after which the groups were established with two or three schools in each role. Having six roles gave a further element of flexibility to the project staff as they were able to create working groups of different combinations of roles.

To provide the opportunities for wide ranging contact with others in the STARS Project, the

membership of each role was changed after the summer holiday (by applying for a job in exactly the same way as on the first occasion) so that the children in any one school operated in two roles. Slightly different formats of pupil involvement were used on the two occasions. In the earlier part, before the summer break, different tasks were given to the combined role groups (see Table 5). Each group of two roles had a different task from the others in Phase 1 (which comprised STARS Trek Blast Off! and STARS Trek Orbiting Earth).

In the later part (see Table 6), the combined role groups started working separately but on the same task, thus deriving three sets of solutions to the same task from the three combined groups. In the STARS Trek Phase 2 activities, the tasks were also designated for all roles and therefore all of the children, although the arrangement of working groups varied.

Despite the relatively short time spent working in a combined role group, some of the children began to identify with the other members of their group and initiated conversations both in relation to, and separate from the context of the STARS problems. This made use of the MailBox and Chat facilities of FirstClass and was generally seen as supportive.

"Pupils did enjoy communicating with other schools"

"...definitely a valuable extension of the classroom"

2.5.3 Support for the teachers

Following advice from the Education Authority Advisors, the teachers were not asked to give up their time to prepare the learning material for use in the STARS Project. Rather they were provided with Teachers' Notes for each of the tasks along with, or a few days in advance of, sending the STARS tasks to the pupils. These notes were for guidance rather than for prescription but did provide an explanation of the types of pupil thinking which each task intended to highlight.

Examples are.

SUGGESTIONS FOR TEACHERS - Bouncing Around
In some respects this is a good task for all ages because the task is physically easy to carry out. The important aspects are, of course, accuracy/consistency and how to establish this across several schools, as well getting a whole range of different bouncing objects to be able to submit a comprehensive report on bouncability.

It could be worthwhile encouraging your pupils to think beyond the most obvious factors affecting bounce (size, weight, height of drop, material and shape) to include floor composition, smoothness of surface of bouncing object, temperature, air pressure, wind, or even colour.

SUGGESTIONS FOR TEACHERS - That's Life!
This first part might be a relatively concentrated activity (although the formats could vary (written activities, open discussion, sharing and extending ideas, brainstorming etc.). We hope that your pupils will come up with a few suggestions

under most of the headings given in the task.

If necessary you could help them get started by asking something like
What is there about appearance (or size, behaviour etc.) which tells you if life is present or not?

In the second part they will have to look back at the descriptors of their appointed role and apply them to the available information in the data bank to select the most appropriate to fit the role descriptor and then agree with the others in the same role what the final statement will be. This may mean that the **constraint** of the role descriptor **conflicts** with their own general view submitted in the first part of the task. They must also, of course, reach a consensus.

The Teachers' Notes were located in a separate conference, not accessible to the pupils in the project. It was therefore possible to summarise how much use made of this aspect of the support for teachers.

Information was provided separately for all of the 15 Stars tasks. Table 4 gives the number schools which read this extra information.

less than 4 tasks	4 - 7 tasks	8 - 11 tasks	more than 11 tasks
2	4	7	5

Table 4 *School use of Teachers' Notes for Stars Tasks, includes all Primary schools involved, whether in Phase 1 only, Phase 2 only or both.*

The variation in the use of these notes indicates that not all teachers found them necessary, although the comment of one teacher struck a chord,

"At times this was a godsend due to pressure of time".

Teachers were also provided with suggested Guidelines for linking the STARS tasks to the ongoing work of the curriculum as suggested in the 5-14 Guidelines. The teachers found these more supportive towards the end of the project than at the beginning.

The Seminar arranged for teachers and members of the Education Authority staff involved took place about half way through the Project. This provided a much needed and warmly welcomed opportunity for an exchange of comments and views, to put faces to names and to influence what happened next. Perhaps the major supporting aspects of the Seminar were a shared feeling of the pleasures and the problems and a genuine wish to continue. A reaffirmation of the teachers' identity with, and ownership of the STARS Project was a major and satisfying outcome.

Some specific suggestions from the seminar were to directly influence the progress of the

project. Following the teachers' suggestion, involvement in the more advanced technology and resources available through the World Wide Web and video conferencing would be on an optional basis. Additionally, information about the STARS tasks would be shared earlier and on a more interactive basis during the second phase than it had previously.

2.6 Timetable of the Learning Tasks

The STARS Project was planned to start in January 1996 and run for one year. During January and February 1996 the schools were selected by their respective Education Authorities and were provided with necessary computers, modems and FirstClass software.

The first task was posted to the schools during the third week in February 1996 but before the first response could be sent back there was technical fault with FirstClass which gave rise to an usually long shutdown of the system until the beginning of March 1996.

The programme of the learning tasks was phased across the following 10 months until the end of 1996 and with breaks for the Easter and Summer school holidays. With the approval and co-operation of all involved there was a short over run into January 1997 to allow for completion of the final task. There was a broad divide into two Phases, the first before the summer break and the second following it.

2.6.1 Phase 1

For the reasons mentioned earlier, the first tasks presented to the project pupils were 'stand alone' tasks. There were 4 of these tasks and they were planned to last in total for about 5 to 6 weeks. The start and finish dates were not intended to be firm, so that schools which required a little longer to fully participate in the project would not feel unduly pressured or left behind. It was hoped that this approach would last until the Easter break for schools after which a more co-ordinated programme was envisaged.

The first four tasks were

STARS1. **Penny for your thoughts** - presenting coins to a bus conductor for payment of the fare.

STARS2. **Seesaws** - using a seesaw for weighing people.

STARS3. **Tall order** - a short person using or not using a lift.

STARS4. **Changing world** - the effect of changing basic shapes in common objects (eg. circles to triangles).

Setting up the groups using the STARS Trek roles was started immediately after the Easter break and was followed by issuing the first of the context related STARS Trek tasks. At this stage the groups were combined to form three larger groups, each comprising two of the STARS Trek roles. There were 5 or 6 schools in each combined group.

To encourage a wide experience of contact with children within the STARS Project, the STARS Trek tasks were arranged into two 'waves'. These were all set into the context of a STARS Trek and followed the initial stages of a possible space journey with the first wave called "Blast Off!" and the second called "Orbiting Earth". Each of these waves had three tasks (all different) and the combinations of the role groups changed from the first to the second wave (Table 5).

Wave	Tasks	Pupil teams
Wave 1 Blast Off!	**Gifts** - selecting and matching gifts for unknown aliens using a set of criteria provided	Space Anthropologists and Counsellors
Wave 1 Blast Off!	**Red Alert** - a variant of the Towers of Hanoi problem set in the context of fuel rods	Sparkies and Communicators
Wave 1 Blast Off!	**Doctors Who?** - working out the arrangement of people around a table from information supplied	Scientists and Navigators
Wave 2 Orbiting Earth	**Weight and see** - devising a means of weighing air	Sparkies and Counsellors
Wave 2 Orbiting Earth	**Bouncing around** - investigating the properties of bounce	Scientists and Communicators
Wave 2 Orbiting Earth	**Catching the planets** - a space navigation context for calculating distance, speed and time	Navigators and Space Anthropologists

Table 5 *Allocation of combined role groups for all context based (STARS Trek) tasks in Phase 1.*

Each of the two waves lasted around 3 to 4 weeks and during that time the pupils had to identify the problem and derive a solution initially in their groups within the classroom in each school. These solutions then had to be shared with the other role members within the enlarged group for each task. For example the 3 schools who were Scientists shared their solutions with the 3 schools who were Navigators for the Doctors Who? task in Wave 1 and then in Wave 2 went on to share with the two different schools who were Communicators, for the Bouncing around task.

Each task was only completed when all the schools in the combined role group had consulted with each other and arrived at a single solution which was then sent by them to Mission Control. The aspect of this which required considerable support by both the teachers in the schools and the project team, was making arrangements for small groups of schools to establish meaningful communication with each other. With many messages being sent between schools for their comment and reply, sometimes a school which had other things to do may not have been aware that a message was waiting for them. This led in turn to some pupils asking why their suggestions had not been answered. Patience and the use of the telephone were both called upon to resolve such minor difficulties.

During the last 3 weeks of the school term before the summer break in 1996, a single STARS Trek task was sent for all schools to attempt. This comprised two parts as follows

> **That's Life** - compiling a database of identifiers or features of life and then extracting and agreeing on a selection which fits specified conditions.

The first part, compiling the data base, was carried out by the pupils in their own school. Moving into single role groups (the three Scientists schools together and the three Navigators schools together etc.) each group then had to work together to agree on a selection of features of life from the complete database, using the role descriptors (see section 2.5.2) as a focus for their selection (for example the Communicators "think accuracy is very important"; the Sparkies "believe in very practical solutions" and the Scientists "have a searching approach to critical thinking").

This final task finished with the closure of the schools for the summer break in 1996.

2.6.2 Phase 2

Phase 2 followed the Seminar for teachers and Education Authority staff involved in the STARS Project. Resulting from this Seminar a complete timetable of the Phase two tasks (see Table 6) was sent to all participant schools two complete weeks before Phase two was due to start. Because all the schools in the project have an October break, the actual start time was delayed to allow most of the schools return to normal classroom routines.

The two types of task, Stand alone and STARS Trek, were continued from Phase one. In addition for a selection of the schools, there was the option of attempting a task based on the World Wide Web and the possibility of experimenting with video conferencing.

A suggestion had also been made at the Seminar for an opportunity for the Project schools to

share their own data using a FirstClass conference. This additional strand to Phase two was therefore provided as the 'Opt In Facility' but was actually not taken up by any of the schools in the Project.

The stand alone tasks were

STARS5. **Got a problem** - 3 short examples: reversing a moving object without touching it; using evidence at crime scene to instantly identify the offender; how to tell if someone is truthful or lying. Then devising a problem for others.

STARS6. **Police line up** - sharing information with others to get a full set of clues to apply to the arrangement of suspects and identification of the culprit in a line up.

The STARS Trek tasks were again based on the establishment of groups and the roles introduced in Phase one were used once more. As there were some changes in the composition of the groups in most of the Project schools (and a new school had joined the group), the procedure for selecting a role through a job application was also carried out again. This was completed before the issue of STARS6 so that inter group collaboration could be introduced before the commencement of the contextualised STARS Trek tasks (see Table 6).

There were two STARS Trek tasks

Egghead - designing and constructing an egg cup using card and no fixative; sharing description with other schools and using such description in further construction.

Insight on a Site - using a list of artefacts to decide about an alien lifestyle; posing yes/no questions to aliens to obtain more information; presenting an agreed composite report on the implications for humans.

The Task involving the use of the World Wide Web (**Earthfile**) was based on the structured use of a very small selection of Web pages. This involved the project staff in creating a STARS web site located within that of Northern College. A fuller description of this is given in section 4.5.4.

The pupils in the schools selected for this task (from those volunteering to be involved) were first required to establish a set of criteria for seeking and extracting information from the recommended Web pages (information pages about animals) and to agree this structure with all the others involved. Then the pupils from each school searched the Web pages and extracted suitable information on their chosen animals for an entry onto the Earthfile. The Earthfile would become a composite document to include the entries from all the schools undertaking the WWW task.

Although it was intended that the selected web pages would be sufficient to complete the task

without search further, access to additional pages was not excluded.

The task ended with a combined, and structurally consistent report based on the information taken from the Web pages used. The intention was that once completed, this final report - an Earthfile for use by aliens who might be encountered during STARS Trek - was to be distributed to all the schools in the project, most of whom would not have been involved in the World Wide Web task.

This final task was also the only one to include the two Secondary schools in the sample. They were selected by their respective Education Authorities for this final stage in much the same way as the Primary schools had been identified. To help these schools fit into the context of all the earlier work, they were allowed free access to all the information contained in the conferences for the preceding tasks.

OPT IN FACILITY	STAND ALONE TASKS	STARS TREK PROJECT TASKS	WWW and/or VIDEO CONFERENCING
(ongoing) There will be the opportunity for the derivation of your own shared learning environment on an 'opt in if you like basis . This could include information sharing or task sharing of your own creation. The first one could be on the collection and sharing of local weather information. Other suggestions are welcome for new STARS databases	**21 October 96** Issue of STARS 5 task "Got a problem?" To be used to introduce (and reintroduce) the new generation of STARS pupils to the ideas of critical and creative thinking as well as co-operative learning. Other aspects, identification of the teacher's mediating role in task related activities sufficient time for pupils' individual and class work as well as comparison of responses with those from other schools opportunities for interaction with other schools.	**4 November 96** Issue of STARS TREK role application papers.	**7 - 20 November 96** Establishment of WWW trial schools (on a voluntary basis)
	11 - 15 November 96 Issue of STARS 6 task "Team Building - Police line up" THIS IS A BRIDGE BETWEEN STARS TREK AND STAND ALONE TASKS This task relies on inter school co-operation for its completion.		
	25 November 96 STARS TREK Phase 2 Issue of common task for all roles, "Egghead". This is a technology related task and linked to 5-14 curriculum. It also requires sharing within role groups **9 December 96** Issue of final task, "Insight on a Site" also with an emphasis on co-operation.		**30 November 96** WWW related task "Earthfile" **9 December 96** Possible limited trial of video conferencing.
	16 December 96 Sharing of relevant WWW experiences across all STARS schools.		

Table 6 *Complete programme for Phase 2 as issued to all Project schools.*

3 Underlying Theory

3.1 Learning through Thinking

There has been an emphasis in recent years on the relationship between children's learning and thinking in the Primary school (such as Bonnett, 1996; Bjorklund, 1990; Coles and Robinson, 1991; Fisher, 1990, 1997).

Some of these concerns for children's thinking appear in a range of fundamental issues relating to modern educational philosophy, such as

- structuring the learning process for desirable learning outcomes.
- introducing problem solving across the curriculum
- giving children the opportunity to makes choices
- increasing pupil autonomy in the learning environment

The first of these probably focuses significantly on achievement standards where the popular terminology includes 'skills-centred', 'key stages', 'achievement targets' and 'national standards. The others identify more with terms such as 'child-centred', 'problem solving', and 'self awareness'. It is also in these latter area where thinking skills and teaching thinking appears to be more widely accepted.

The evidence from the literature seems to suggest that teaching thinking is possible (see for example Nisbet and Shucksmith, 1986). The areas of current debate appear to be

- how to identify or define what comprises the thinking to be taught,
- how to structure the learning environment and
- how much teaching thinking may be independent of curricular teaching

There is often a vigorous debate of the relative positions held and much remains to be

clarified (see for example Craft, 1991; Ennis, 1987; McPeck, 1981; Mulcahy, Short and Andrews, 1991).

This was the situation facing the STARS Project as it set out to address the promotion of learning for able pupils in small rural schools. Teaching thinking was selected as the approach for the project because it was expected to be different from other ongoing classroom work. It should be challenging for able children and it could be supported in terms of acceptable current pedagogy.

The approach of Ennis (1995) was taken as the starting point for identifying an approach to teaching thinking for the STARS Project. This approach suggests a view of teaching thinking through problem solving which postulates two key aspects of thinking - critical thinking and creative thinking. These two overlap in some respects and where they do, this might be a more precise form thinking which Ennis suggests is reasoning. This relatively straightforward approach, based in a problem solving learning environment, appeared to fit with a computer managed approach to learning.

The STARS Project aimed to provide a structured learning environment which would be sufficiently familiar to the pupils that they would find the approach acceptable yet challenging. The problem solving approach was selected and the focus on critical and creative was seen to be appropriate for presenting opportunities for motivating and stimulating learning. The use of the computer managed communication system of FirstClass also fitted well with the scenario of presenting a self contained learning task to the children in the classroom and providing a means of writing replies or solutions to be shared with all the learners in the extended group.

In the early stages of the project, the suggestion by Ennis that critical and creative thinking might overlap in what might be termed reasoning was given less attention. In the later stages, however, it was possible to identify a form of reasoning at this overlap stage.

3.2 A Context for Teaching Thinking

There is considerable debate about how teaching thinking should be implemented in the school classroom. One of the arguments most pertinent to the STARS Project was how much the project tasks should be linked directly to the ongoing curriculum.

There are at least two related issues. One relates to whether thinking should be introduced as a separate course of study or linked in with existing curriculum courses. The other refers to

the form of curricular integration, should it different for each curricular area or wholly integrated in a cross curricular format?

Nisbet (1991) argues that the teaching of thinking skills promotes the strategies and techniques of thinking which are "too important to be left to chance". The difference between teaching knowledge and teaching thinking is typified by the difference between an information based approach and a problem solving approach to classroom learning.

If teaching thinking is implemented through a separate course of study, it is likely to involve the identification of intellectual or thinking skills. There are many programmes which have the skills approach as their pivot and they have a widespread following, having been tried in many countries of the world. There are, however, dangers in following any one single programme; or selecting one set of skills rather than another; or placing an excessive focus on routine procedures; or giving less attention to the 'the whole' in favour of the 'the parts'.

If thinking is not taught through a separate course then it becomes part of the curriculum. Nisbet (1991) refers to this as the "infusion" process whereby thinking becomes an integral part of teaching and learning in any subject or all subjects. He suggests that the means by which this can be achieved include modelling, questioning, discussion and co-operative learning.

Through modelling the teacher makes her strategies for tackling the learning situation explicit to her pupils and ensures that this form of interaction and sharing is implemented and exhibited regularly. Questioning and discussion are well established and widely employed among the popular techniques for extending children's perceptions, concepts and conclusions. Such approaches should encourage learners to make personal links within their own understanding and to derive their own explanations.

In addition, co-operative learning is expected to foster an attitude for sharing among learners so that they can learn with a group, and from each other.

The use of problem solving to promote the "infusion" of thinking through the established areas of the curriculum is appearing more frequently in educational syllabuses. It is particularly favoured in the primary school through a widespread involvement of children in projects. So, perhaps it could be argued that there already exists a curriculum focused approach for involving children in thinking.

However, the use of problem solving, through projects or investigations, gives rise to the second controversy. Views differ in terms of how much problem solving can be used to

promote thinking skills in specific curricular areas as domain specific skills, or whether they are transferable into other subjects as general thinking skills (Craft, 1991; Ennis, 1989; McPeck, 1990).

The main points at issue centre around different views of how many separate parts thinking skills can be divided into. The more separate skills there are, the more likely there is to be an attraction to domain specific teaching. If there is a smaller number of core skills they may be seen as either cross curricular or stand alone and taught separately.

Finally, the role of the teacher. In problem solving the teacher serves as a mediator, ideally through selecting the most appropriate problems for her pupils. This will take account of the children's' learning needs appropriate to their social and cognitive development and the demands of the learning environment. Vygotsky (1978) suggests that "properly organised learning results in mental development" which could be taken to include the development of thinking skills. The means by which teachers will mediate during the learning process (the 'zone of proximal development') might be expected to include the modelling, questioning and discussion referred to above.

The STARS Project tried to adopt a position which crossed some of the ground between these different views. There was a belief in the potential of identifiable thinking skills and an acceptance of the dangers of following any one programme for teaching thinking in this way. The project team also recognised the acceptance of the general thinking skills which could be supported through problem solving tasks. There was no wish to focus specifically on one area of the curriculum and the hope was that the problems presented would be integrated by the teachers into different aspects of ongoing school work. The needs of the Scottish 5-14 Curriculum Guidelines were therefore very much in mind as the STARS learning context was created. There was also a strong focus on co-operative and collaborative learning.

In the STARS Project, there was a further factor. The children in the project were not known to the project team and therefore their learning needs were not specifically known when the tasks were devised. Also, the varying approaches to learning which the different teachers used or which the classrooms dictated, were not known. The selection of the learning tasks was therefore not as the teachers might have preferred to suit their own approach to mediation.

3.3 Critical and Creative Thinking

In the examination of the possible teaching programmes for promoting intellectual or

thinking skills, a cross-curricular emphasis was favoured. It had also been decided that much of the material would have to be modified or created to suit the computer managed learning environment of the project. Therefore there was the opportunity to select material which reflected the variety of approaches reported in the literature.

The approach suggested by de Bono (1976, 1985, 1986) is to "crystallise different aspects of thinking into definite tools." Each of these is taught separately and children are encouraged to apply these newly learned skills in future problem solving environments. Learning by de Bono's CoRT method takes children beyond understanding the skills or tools, to be able to use them in practice.

Although the term 'lateral thinking', having been originated by de Bono, is most commonly linked with his approach, there is actually a great deal more to his suggestions than the creative approach. It involves the place of logic and discussion, the value of knowledge and algorithms, as well as the role of structure which is seen as liberating rather than restricting the development of thinking. The value of the tools of thinking is to allow the learner to apply a wider range of skills than he might otherwise have used, to a new problem solving situation. There is also an implication in de Bono's approach that by improving children's creative and critical thinking skills, they might be better able to make the most of their natural ability.

Structure also figures prominently in the philosophy for children approach proposed by Lipman (1991). His emphasis is on teaching reasoning with a target of achieving "full efficiency" in much the same way as children are expected to be completely correct with spelling, syntax and grammar. As with the de Bono approach, Lipman sees children being taught a "kit of reasoning tools" which they could use both in and out of school. Critical and creative thinking become variables in a relationship which is the basis of higher order thinking.

Lipman supports the notion of the classroom as a community of enquiry where pupils will share ideas and suggestions; listen to each other and respect their contributions; critically comment on and question the proposals of others; offer and expect to be offered explanations for thoughts and recommendations; and adjust their own concepts as a result (Lipman. 1991; Cam, 1995; Splitter and Sharp, 1995). This approach has strong links with the current view of collaborative and co-operative learning (see Davidson and Worsham, 1992, for a good summary).

While recognising the need to improve children's intellectual skills, the aim of Feuerstein's Instrumental Enrichment (FIE) proposals for teaching thinking is to involve the teacher

more prominently as a mediator in the learning environment (Feuerstein et al, 1980; Feuerstein, 1986; Blagg, 1991). The driving force of FIE is its belief in cognitive modifiability whereby individuals and their intellectual functioning can change through learning how to learn.

In common with the other approaches, Feuerstein talks about the "tools of his trade", these being instruments aimed at highlighting particular kinds of thinking process. There are also key goals of the FIE programme which aim towards increasing children's capacity to develop or improve through interaction with the learning environment. Some of these are: acquisition of concepts and vocabulary; motivation from the learning task itself; enhanced self perception by the learner; an insight by the learner of his progress in thinking strategies; and motivation through the formation of habits.

Sternberg (1985, 1988) proposes a three part model of human intelligence and thinking - analytical, creative and practical. Analytical thinking, which includes critical thinking, involves judging and evaluating, examining and analysing. Creative thinking is the high quality, task related activity which involves imagining and suggesting, discovering and producing. Practical thinking usually implies making links with personal experiences, applying and implementing, using and operating.

Applications to the classroom (Sternberg and Spear-Swerling, 1996) suggest that each of these three plays a separate part in pupil learning alongside the widely recognised teaching of subject content or knowledge base. Sternberg suggests that knowledge learning might be substantially memory based and that this should be kept in balance with children knowing how well to use what they know. Application of the Sternberg model aims at the achievement of thinking through four steps in problem solving: familiarisation, intragroup problem solving, intergroup problem solving and individual problem solving.

The learning tasks in the STARS Project adopted a 'broad brush' approach to attempt to reflect elements of all these approaches mentioned, without a firm adherence to any one or another. The attention to either critical thinking or creative thinking or a combination of the two, varied both from one task to another and from the earlier stages to the later stages of the project. Aspects of each of the approaches were identified as the learning tasks were created and after they had been used by the children. In this latter way it was possible to identify corroborative features in the children's thinking activities which matched more than a single approach.

Some of the aspects of critical and creative thinking which were identified in the STARS tasks, are listed in Table 7.

CRITICAL THINKING
- identifying the nature of the problem
- examining and analysing all the information
- deciding what contributes to finding the solution
- discriminating between appropriate and distracting information
- recognising assumptions on which the problem is based
- making judgements
- forward and backward thinking
- testing hypotheses with the information given
- employing self correction and questioning
- looking for relationships
- identifying and applying rules
- taking decisions
- being systematic and logical
- using trial and error (or guess and improve),
- making and using models
- employing reasoning skills
- making discoveries
- sorting and reorganising the information given
- justifying selection of information
- structuring for a purpose, such as making something more easily understood
- ensuring accuracy and consistency
- taking account of all the factors
- resolving contradictions
- selecting from alternatives
- being sensitive to context
- planning and predicting
- comparing and contrasting
- brainstorming
- critically analysing dominant ideas
- integrating information from several sources
- taking account of constraints and conflicts

CREATIVE THINKING
- changing ideas from the most obvious
- looking at any other reasonable alternatives to fit the description of the problem
- thinking of something new and different
- identifying creative (novel) uses of everyday objects
- suggesting change to accepted conventions.

Table 7 *Sample thinking skills included in the STARS tasks.*

3.4 Co-operative and Collaborative Learning

There are different ways of defining the approaches to learning which place a strong emphasis on acting together, co-ordination, social relationships and shared goals. Johnson and Johnson (1989, 1994) suggest that learning together on a task set by the teacher and having a specified outcome should be called co-operative learning. The view of Galton and

Williamson (1992) is that children working together on different sub-tasks to achieve a joint piece of learning is co-operative learning and the collaborative learning should be used for group work on the same task, at the same time with a single outcome. A slightly different view is suggested by Hart (1990) wherein co-operative learning is a corporate feeling of belonging within a classroom, whatever form the task completion takes.

The chosen focuses of the STARS Project, the promotion of thinking skills and collaborative learning, come together with evidence provided by Johnson and Johnson (1994).

> "Co-operative learning promotes a greater use of higher-level reasoning strategies and critical thinking than do competitive or individualistic learning strategies" (p57)

This is supported through studies by many researchers into reasoning, focusing and elaboration strategies as well as problem solving procedures.

For the STARS Project the important aspect of co-operation and collaboration was seen as working together as a group for an agreed outcome. This included children taking part in discussions; sharing their views, suggestions and ideas; extending their own contributions using the suggestions of others; being willing and able to compromise or resolve conflicts with their own views; and to reach a consensus position before presenting a solution for a problem solving task.

The collaboration and co-operation had to take place at two levels. Working together within the classroom was one level and should have been a familiar and well used approach for most children. The second aspect of collaborating with children in a different school on a classroom based learning task was new and the use of the computer intranet to communicate all details of the problem solving task made the learning environment a wholly innovative experience for all the children involved.

Different formats of computer supported or computer managed collaborative learning are described by McConnell (1994). He identifies 3 basic variables which could lead to different types of system: work can occur synchronously or asynchronously, users can be located remotely or in the same location and the learning environment can be structured or unstructured.

McConnell further suggests that there are some key features of computer supported collaborative learning which are important in designing a learning environment. They include a supportive learning environment, a real purpose in the collaborative process and a measure of self determined learning. The STARS Project attempted to reflect all of these in

its design.

The particular aspects which were identified for the STARS tasks are listed in Table 8.

COLLABORATIVE LEARNING
sharing views and ideas
extending views and ideas using the suggestions of others
resolving conflicts with own view
reaching consensus or agreement with the others in the group
collaborating to be clear about the problem
sharing with others to establish a common structure for achieving a solution
working together as a group for an agreed outcome
taking part in discussions
being willing and able to compromise
being aware of the views of others before speaking

Table 8 *Sample collaborative learning skills included in the STARS tasks.*

3.5 Use of Communication Technologies in Teaching and Learning

From the increasing number of publications dealing with information and communications technologies and learning, there are some which relate to the underlying theories and philosophies. For example, there are suggested links between the Piagetian stages of development and associative thinking (Nichol, Dean and Briggs, 1987), between Vygotsky's view of supported learning and the social learning environment of the classroom (Fowler and Wheeler, 1995) between the constructivist learning environment and critical thinking skills (Ryser, Beeler and McKenzie, 1995) and the postulation of a computer-based instruction model of communication (Szabo, 1995).

Reports on studies of undertakings similar to those of the STARS Project are fewer. Burger and Farragher (1995), however, report a study on the use of electronic communications to promote learning in the classroom. They identify the importance of the "teachers and the strategies they use to incorporate collaborative learning into their educational practices". They also report an "excitement and enthusiasm which needs to be focused before the momentum is lost". Apart from the practical outcomes reported, Burger and Farragher also raise some of the more general issues - such as global sharing of knowledge and information as a part of the learning experiences for children, and issues relating to the introduction of innovation or change into the classroom.

Learning through using information from the World Wide Web presents a much more complex picture. Owston (1997) examines the questions of whether the Web makes learning

more accessible and if it promotes improved learning. In terms of access, Owston suggests that attempts to introduce the use of the Web into pupils' learning at the public school level is not yet widespread, though in other areas such as the private sector or home education there is an expanding access and use of quality learning materials.

The question of whether use of the Web promotes improved learning remains a matter of debate. Owston (1997) summarises the current position, indicating that improved learning may rest more heavily with instructional design than with the medium used to deliver that instruction. He further argues that it is not realistic to expect use of the Web to develop any unique skills. More likely, it is the way the learning environment is constructed to make use of the Web as a resource, which may influence learning outcomes.

Among the aspects of learning which the use of the Web seems to have most to offer, are pupil motivation, autonomous learning, up to date resources, flexibility in learning and new opportunities. Much of this still has to be fully explored, although it is interesting to note that among the skills involved in using the Web in the learning environment, are critical thinking, problem solving, written communication and working collaboratively (Uchida, cited in Owston, 1997).

Little appears to be known about how to enhance learning using such non linear and multidimensional systems as the World Wide Web. Jacobson and Spiro (1995) propose a cognitive flexibility theory which identifies the need for different systems for the processing of knowledge from complex systems, compared with those used for well structured domains. Their proposals include multiple representations of knowledge, the use of multiple case examples for abstract concepts, introducing complexity at an early stage, stressing the interrelated nature of knowledge and encouraging knowledge assembly rather than retrieval from memory.

A rather less complex approach is suggested by Astleitner and Leutner (1995) where the process of learning is seen as comprising three components; locating specific information, finding out how to reaccess this information from any point within the hypermedia system and derive a means of linking or integrating these accessible pieces of information.

The STARS Project addressed these issues only in a very superficial way as there was only a single Web related task and it was undertaken by a small sub-sample of the schools involved in the project. The main focus in deriving the task was to prevent excessive unstructured searching for information, without destroying the innovative nature of information retrieval from the Web. This was attempted through the establishment of a pupil derived and agreed structure for the task before Web searching began.

All the elements identified by Uchida (cited in Owston, 1996), critical thinking, problem solving, written communication and working collaboratively, were included in the STARS Web task.

4 The Analysis of Outcomes

4.1 Focus and Purpose of the Analysis

The STARS Project set out to investigate how information and communication technologies can support learning in the small rural school, with a particular emphasis on able children. There were three focuses

- the learning benefits for the pupils
- professional development of the teachers
- the effectiveness of the technologies

The evidence for this analysis was collected in two different ways. The use of the FirstClass system provides a record of all the contributions made in each conference within the closed intranet. Accordingly every message sent to the pupils and every reply using one of the conferences is available for examination. There is no permanent record of exchanges between pupils using the MailBox or Chat facilities. The children were encouraged to use these facilities but to ensure that they sent all the responses to the learning tasks through the conferences. Consequently, although some useful exchanges may not have been recorded it is felt that all the relevant information about the solution of the problem solving tasks is available for analysis.

The second form of collecting data is through direct questioning of the pupils and the teachers. This was carried out in three sessions. The first was addressed to the teachers in June 1996 and covered the appropriateness of the learning environment provided, children's learning gains and support for teachers. This collection of information was administered partly through a telephone interview and partly through a questionnaire. The questionnaire was passed to the school both by electronic mail and by traditional mail.

A more specific enquiry was carried out in November 1996 in relation to the teachers' involvement in the children's learning and this was examined in the context of the learning

task STARS5 (see section 2.6.2). The third set of data was collected from the teachers and from the pupils in February 1997, after the project had finished. This looked at pupil learning, the special circumstances relating able children and teacher expertise.

Additional information was available throughout the entire project by means of the frequent contact between the project staff and the schools involved. Much valuable evidence was collected in this way with regard to issues in relation to the technology used and the professional development of the teachers. These exchanges took many forms; electronic mail messages, fax messages, telephone conversations and FirstClass chat.

The analysis of the outcomes addresses the following aspects

the learning tasks	- appropriateness and relationship to the existing classroom routines
	- using the World Wide Web for learning
the pupils,	- identification with, and involvement in, the learning environment provided
	- learning gains in ICT skills, thinking skills and in collaborative learning skills
the able pupils	- specific gains
the teachers	- mediation in children's learning
	- professional gains
the systems and technology	- telephone communications
	- appropriateness of FirstClass
	- videoconferencing
	- access to the World Wide Web

4.2 The Learning Tasks

All of the schools, except those within the Education Authority who withdrew in the summer of 1996, were involved in all the STARS tasks, that is the Stand alone as well as the STAR Trek tasks.

The only exception was the additional small self selected sample who completed the World Wide Web task.

4.2.1 Appropriateness of the STARS tasks

In the early stages of the project, the teachers had little opportunity to influence the creation or selection of the learning tasks. This situation improved as the project progressed and there were some of the later tasks which relied considerably on teachers' suggestions. The very first tasks were sent to the teachers and pupils at the same time, but with the teachers' versions were included the suggestions for teacher involvement and possible solutions to the problems.

When the teachers were asked to become part of the project they were given very general advice, via a Starter Pack, about the decisions which they should take regarding the use of the learning tasks in the classroom. The prevailing conditions in the classrooms of the project schools meant that initially there would be considerable variation in the handling of the STARS tasks. This was expected to include the priority given to the tasks, the time to be spent on them, the classroom arrangements for teacher support and the links which could be made with other ongoing pupils learning activities.

As the project progressed there was a significant amount of 'coming together' as the teachers became more familiar with all aspects of the project. Everyone involved, including the project team, became more informed about the learning environment and the individual differences in previous experience seemed to progress towards a common understanding of the demands and the potential rewards of the undertaking.

The teachers were asked in June 1996 (4 months after the start of the project and at the end of Phase one),

"How suitable have the tasks been for your children?"

"How well have the tasks fitted into your ongoing classwork?"

The answers given were often wider than the questions posed, indicating such influences as the challenge which tasks had provided to pupils' thinking and learning. Of the 10 schools responding, all indicated positive views of the tasks' suitability, with half indicating that they had fitted in well with classwork and half suggesting that they had not. It is a great credit to the teachers that they felt, even when the tasks had not fitted in, they were "intrusive but useful".

The timing and pacing of the STARS tasks was potentially a difficulty. The schools were expected to complete the tasks in a timeframe which was dictated by the Project and not by the schools. With even with a relatively small number of schools, the differences in classroom approaches and the needs of a fairly wide age range of pupils was certain to make

this timing and pacing difficult. In addition note had to be taken of the range of such other additional Primary school activities as Christmas Concerts, Summer trips and School Sports. Despite this, only three of ten schools responding to a question about timing and pacing, suggested that for them it had not been right.

4.2.2 The World Wide Web task

For the World Wide Web task a small sub sample of four Primary schools and two Secondary schools was selected on the basis of them having requested involvement. Only one of them had used the WWW before in the classroom and therefore the remainder required to be provided with and introduced to the software to access the Web. Instructions, documentation and onsite assistance were provided in most instances to help the schools but technical difficulties associated primarily with slow modems meant that 2 of the Primary schools were unable to gain satisfactory access to the Web and therefore could not participate. further.

Of the remaining four, the two Primary schools worked together as did the two Secondary schools.

The task was called EARTHFILE and required pupils to search recommended Web pages for specified information about animals. The nature of the specification was to be agreed between each pair of schools so that what they finally produced would have a common structure and would read 'as one' when finally presented to others. Full details of what was expected in this new form of collaborative task were supplied to each of the schools and support from Project staff was always available to assist in tackling any technical or educational problem.

As with the other STARS tasks, the teachers were given additional information and suggestions about the focus of the task and the major elements to be stressed.

Although based on the experience of a single task the general impression of all the schools involved, about the value of the World Wide Web as a resource for learning, was very positive. Comments included, "amazing potential", "the potential is enormous", "good but time consuming", and "impressed and want to explore more".

The teachers also identified a number of issues which influenced their pupils' learning through the Web based task. The positive influences included having to accept some responsibility for their own learning, gaining experience in discussing and sharing with other pupils, agreeing on a plan of action, broadening horizons and reaching compromises.

The difficulties were mainly associated with the very slow accessing of Web pages and downloading information. This, along with some difficulties in arranging to exchange

suggestions with the other school, sometimes led to pupils focusing on activities not related to the STARS task.

These views were confirmed by the pupils. They found the use of the Web to be "..more practical, .. faster and it is more up to date ". They learned that in agreeing a common structure for the Web task, "it is quite difficult for everyone to co-operate" and that "you just have to come to a compromise". Not every pupil found the establishment of the structure for finding and extracting information to be helpful, though most of the objections were linked with delays or difficulties in interschool communication.

The pupils' own suggestions for the extended use of Web pages in the classroom included project work and subject areas such as History, Geography and Modern Studies as well as its use an encyclopaedia. They were also aware of the disadvantages of limited computers permitting only slow access and retrieval times of Web pages, and they wanted an "index of good pages". This latter may be an indication of pupil awareness, even with very limited experience, that the World Wide Web contains a lot of pages which are of little value to them.

4.3 The Pupils

There were 116 pupils at the Primary school level who were involved in most of the STARS tasks. Some of the Primary schools involved other groups of children in certain of the tasks although in the main they did not use the FirstClass conferences to communicated their responses or suggestions and therefore do not figure in the analysis of the findings. The eleven pupils at the Secondary level were involved only in the WWW task.

4.3.1 Involvement in learning

The project team selected a problem solving approach for the learning tasks to present the pupils with some challenges. It was expected that many of the pupils might have had limited experience of this approach outside the mathematics area of the curriculum. It was also decided that the language used in the tasks should be demanding on occasions and that some of the concepts introduced, should aim for a higher level of understanding.

This was noticed by the schools from an early stage and the tasks were found to be "quite demanding", with some instructions "hard to follow", with the language "sometimes a bit heavy". There was a general appreciation however that the problem solving approach, though not always easy, was very welcome as it "tends to be an area that is not given due attention".

Using the FirstClass conference system provided a means of two way communication between the pupils and the project team. When a new task was sent to the schools a separate conference was established with the name of the task. The first posting or file in that conference was always the file containing the task details and every subsequent posting or file would be from the pupils to the conference or replies from the project team.

Particularly in the early stages of the project, a conscious effort was made to acknowledge and comment on every suggestion or solution proposed by the children. In many instances the replies from the project staff were posted on the relevant FirstClass conference the same day as the children's' comments appeared and for the majority of cases, it was within a day or two.

One message from a teacher about this positive feedback to pupils was itself very reinforcing.

> "The children gave a very positive reaction to these answers. Please continue with this as it boosts their confidence greatly to know that someone else out there is paying attention to their work"

For most of the project pupils, part of the motivation for learning in the STARS tasks was the novelty of receiving learning material and giving their answers through an on-line computer. The specific focus on critical and creative thinking and the involvement of collaborative learning became apparent for most of the children as they began to progress through the tasks.

An assessment of the pupils' achievements in the STARS tasks, based on their teachers' comments, was carried out at the end of Phase one and again at the end of Phase two. The first of these analyses show a high level of motivation for all pupils, some awareness of thinking skills and evidence of developing collaborative learning experience. This is summarised in Table 9.

school	general approach to STARS tasks	awareness of thinking skills	promotion of working together
1	feel good about completing the tasks	don't realise how much they have had to think	worked very well as a group and with other schools
2	very enthusiastic; stop and consider what they are going to do	probably not very aware of their thinking skills	raised issues which we have gone on to resolve
3	enjoyed challenges; respond in a more organised way		show signs of responsibility to others in various schools

4	keen and enthusiastic; would have more satisfaction if more time	tried hard to use thinking skills	helps learn about other people, but organising getting together is hard
5	proficient in using technology themselves		worked very well together
6	loved the tasks; some of it was a bit beyond them	thinking of their own thinking skills; latched on to 'critical thinking'	too much distracted to chats with students in the College
7	really enjoyed taking part	realised what thinking skills they have been using	realised the importance of listening to others
8	very interested and thoroughly enjoyed the problem solving activities	were aware of their own thinking skills	has helped pupils working together in school and across schools
9	greatly enjoyed it	a little more aware than before of their thinking	co-operation with other pupils is very important
10	greatly enjoyed the variety of the tasks	creative thinking was particularly good for a pupil	need a bit more of sharing answers

Table 9 *Summary of pupil involvement in learning at the end of Phase 1.*

The information collected at the end of Phase 2 presented a similar but not identical picture. This is summarised in Table 10.

school	how the STARS learning environment has been different	awareness of thinking skills	successful aspects of Stars tasks for learning
A	working through the computer; hard to have tasks which did not have a right answer	too young to realise what thinking skills they were using	they explored possibilities and drew their conclusions
B	using computer to communicate; many answers possible	to some extent through telling others about their solutions	short stand alone items
C	new use of the computer; working with other schools	recognised the processes they used	stand alone tasks very successful as feedback was more immediate
D	responding to wider group of children; clear communication at a distance; immediacy of it	not much	communication in print; accessing WWW information
E	external input and general classroom 'buzz'	not sure, they saw it as fun	
F	more group discussion on open ended tasks; finding answers by questioning; communication with other schools	don't think they were aware of the type of thinking but they did find it difficult	initial stand alone tasks were really effective

G	more time and emphasis on problem solving and IT skills; collaborative thinking, valuing others' opinions	probably not very much	stand alone tasks, especially when they could be acted out; lots of discussion was most successful
H	something special - a bit of status to those involved	not very	
I	communicate and work with pupils in other schools; pupils using new technology	they were aware of the process they were using and of the terms 'critical' and 'creative 'thinking	pupils learned from and enjoyed both stand alone and group tasks
J	no appreciable difference	not to any greater degree than they already had	practical tasks were the most advantageous
K	pupils working on their own; realising their ideas are as good as or better than those of adults	teacher involvement important to increase their awareness of the skills	
L	independent pupil activity; interaction with computer and with other schools; evaluate the work of others	possibly when being asked to evaluate work - their own and of others	not sure
M	contact with other children and access to the ideas of much bigger peer group	certainly became more aware but had to be reminded often	seeing a wider range of responses triggered more ideas; collaboration
N	sharing thoughts and ideas with other schools has broadened their horizons	not sure how aware they were of the skills they were using	problems leading to drama were good and enjoyable

Table 10 *Summary of influence of Stars tasks on pupil learning at the end of Phase 2.*

Several teachers also commented that the tasks themselves were highly motivating,

"..(they) were keen to do more the next session"

These summaries indicate that at the end of the project, after an involvement lasting a little over 10 months, there was a general recognition by the teachers that the STARS tasks had introduced two new aspects to the pupils' learning environment - different use of the computer and communication with children in other schools. The educational advantages of these were reported to include comparing pupils' own ideas with those from a wider peer group; more attention to communicating with people you can't see; more discussion of the learning task in hand; a distinct feeling of being noticed and recognised outside the classroom; more pupil directed learning; and enhanced perception of learning in general and of problem solving in particular.

The teachers also had a slightly different view of their pupils' awareness of thinking skills.

Where 5 teachers out of 10 had been prepared to make a comment at the end of Phase one which could be interpreted that their pupils were beginning to realise what thinking skills were, only 3 of these 5 expressed similar views by the end of Phase two. The two other schools commented at the end, "probably not very much" and "don't think they were aware.." Only a single additional school made the claim that their pupils "were aware of the process they were using", and this school had not submitted the evaluation papers at the end of Phase one.

A possible explanation of this could be that the teachers had advanced their own understanding about thinking skills and were making shrewder judgements about their pupils' involvement and awareness at the end of the project than they had about half way through.

4.3.2 Learning gains

As the STARS Project was essentially a development project employing an action research approach there were no definitive indicators of the children's knowledge, understanding or skills before their involvement began. The project team had collected some specific information about the able children's approach to learning but nothing was known about the other children or about the work programmes or attainment standards pertaining to any of the classrooms.

It was also felt inappropriate to administer standardised attainment measures during or at the end of the project and all the information collected is the product of questionnaires to the pupils and their teachers or from an analysis of the pupil responses to the learning tasks as recorded in the FirstClass conferences.

The information collected by the external evaluation team was kept largely separate from the project team's own evaluation data and links were drawn only after the completion of the project.

4.3.2.1 Learning gains in ICT skills

A general picture of improved ICT skills in pupils (and teachers) was apparent in a number of ways; through comments from teachers during telephone conversations, contributions made during the STARS Seminar for Teachers and Authority staff, visits to schools, suggestions and observations made on FirstClass conferences and chat, as well as from responses to the evaluation questionnaires.

Several schools made comments that the gains had been much wider than just for the children involved in the STARS Project. The headteacher of one single teacher school commented that the "overall IT competence throughout the school" had improved and another that the project

had "shown parents that technology and IT experience is available to pupils regardless of school size".

There clearly was a general increase in awareness of the computer as an part of classroom learning and for those schools who took part in the Web based task, a further awareness of what the WWW is and something about what it has to offer.

In addition to the general observation about "using computers", the comments from the pupils indicated several specific areas where they felt they had improved , as shown in Table 11.

ICT skill suggested	number of schools
improved keyboard skills	√ √ √ √ √ √ √ √
logging on and use of modem	√ √ √ √
use of FirstClass	√ √
experience of Apple Mac	√ √
sending e-mail	√ √ √ √ √ √ √
using the internet	√ √ √ √ √ √

Table 11 *Schools suggesting which ICT skills had shown improvement from STARS Project.*

The pupils from fifteen schools responded to this request and each identified at least one aspect of improvement.

4.3.2.2 Learning gains in thinking skills

Because of the nature of the project, evidence for specific learning gains in individual children is difficult to provide. Rather, the evidence supports a general development of pupils' overt behaviour in their responses to the thinking skills within the problem solving tasks presented.

In the first task, STARS1, the thinking skills involved were

identifying the nature of the problem
examining and analysing all the information
deciding what contributes to finding the solution
discriminating between appropriate and distracting information
recognising assumptions on which the problem is based

A summary from an analysis of 34 replies (mainly from individuals rather than from schools) is given in Table 12.

Thinking skills involved in problem solving	No of time each appears
nature of problem identified	8
clear indication of examination of all information	2
decision about what contributes to finding solution	2
discrimination between appropriate and distracting information	none
recognition of assumptions	8
introduction of completely new information for the solution	12

Table 12 *Frequency of appearance of thinking skills in STARS1.*

In this problem there was probably only one piece of distracting information (one of the passengers went upstairs on the bus and the other remained downstairs), and the main assumption was that 50p could be offered as a single coin or as several coins.

In a later task, STARS5, the thinking skills were similar to those for task 1 with the addition of testing hypotheses with the information given. The introduction of completely new information was different between the two contexts in that only in STARS5 was creative thinking highlighted as part of the instructions for the problem solving activity.

Analysis of 27 replies (there was an increase in the number of "We thought..." responses indicating group rather than individual replies) is given in Table 13.

Thinking skills involved in problem solving	No of time each appears
nature of problem identified	19
clear indication of examination of all information	6
decision about what contributes to finding solution	12
discrimination between appropriate and distracting information	4
recognition of assumptions	9
testing hypotheses with the information given	6
introduction of completely new information for the solution	13

Table 13 *Frequency of appearance of thinking skills in STARS5.*

In STARS5 there was much less distracting information presented but there were some basic assumptions, such as different wheeled vehicles have distinctive tyre widths and there are often distinguishing features of the users, such the clothes they wear.

It is certainly true that some judgement was required to identify which of the aspects of thinking the children were employing, when this is largely based on their recorded comments in the FirstClass conferences. In an attempt to reduce this subjectivity, specific information was collected from a sample of the teachers about how they thought the pupils tackled the STARS5 task. This provided valuable and sometimes extensive information about how the children's thinking progressed through the problem solving activity. For instance it was clear that a much wider range of "new information" was frequently introduced which was not included in the ultimate suggestions sent to the FirstClass conference. It was also evident that the teacher involvement in suggesting directions for fresh or additional thinking, was very important and sometimes essential.

This contact with the teacher served to confirm the judgements made from the children's comments as they are summarised in Table 13. It is likely that the frequency summary suggested is a serious underestimate of the actual thinking which did happen in the solution of even one of the three problems in STARS5.

The difference between STARS1 and STARS5 as suggested by the summaries in Tables 12 and 13 is indicated only as a general trend. The actual occurrences in both cases are probably much greater, although the difference between them probably remains. To interpret this difference in learning gains can only be justified in general terms. It is probably true that there has been a significant improvement in the pupils' ability to identify the problem and work in groups to find a solution. This is not unexpected if experience of such approaches to learning, had not been extensive prior to the start of the project.

There also appears to have been a greater employment of some of the more specific skills such as examining the information provided, taking some decisions about this information and trying out hypotheses against it. There must be a link between using these thinking skills and a progression in pupil thinking, in successful problem solving. The evidence suggests that the pupils were adopting an approach to problem solving which was more structured, logical and rigorous than previously. It may be reasonable to suggest, therefore, that for the pupils involved in the STARS Project, there have been learning gains in some aspects of thinking skills.

Further evidence of possible learning gains in pupil thinking skills comes from a comparison of two of the STARS Trek tasks which required the production of a database and its subsequent interrogation for a specified purpose. These tasks also took place under comparable circumstances in that one was at the end of the school session in June 1996, while the other was at the end of the project. Each task was therefore subjected to similar constraints relating to deadlines.

The first of these two tasks, "That's Life?", asked the pupils to create a database of suggestions about features or identifiers of life. Some suggested headings were offered as a starting point,

appearance
communication
size
conditions for living
activities
tests for life
behaviour
anything else which helps to say life is present

although the advice offered suggested that these did not have to be used. Subsequent examination of the database was in groups of schools based on the STARS Trek roles and the task was then to make a selection from the list the indicators or features of life proposed by the pupils, such that they were particularly relevant to the work of each separate role. So the Scientists were to adopt a searching and critical approach, the Space Anthropologists a more creative approach and the Counsellors were to reflect 'the importance of people'.

The second task, "Insight on a Site", asked pupils to make a database of questions (which could be answered only by a Yes or No) to pose to the inhabitants of an alien world and based a set of artefacts found on that world. The second part of this task also required the children to work in groups based on the STAR Trek roles to use the information in the database to formulate a report, again relevant to the work of each role, on the alien world lifestyle and the implications for possible human missions to that world.

The thinking involved in both of these tasks related to

brainstorming
taking decisions
structuring for a purpose
being sensitive to context
sorting and reorganising
justifying selection
critically analysing dominant ideas
changing ideas from the most obvious
taking account of constraints and conflicts

An analysis similar to that comparing the thinking skills between STARS1 and STARS5 gives a similar indication of a general development from the earlier task to the later one. A different analysis was also carried out, based on the type of suggestions which the pupils made for inclusion in the two databases. Each of the suggestions was placed by two

independent judges into one of three categories

- items which were routine in that they broadly related to the concept of the database without being unusually creative or insightful
- items which were sufficiently innovative to be noticed and that the nature of this innovation was closely linked with a better than average understanding of the context for deriving the database
- items which were again sufficiently innovative to be noticed and were indicative of a much broader (possibly advanced) understanding of the context for deriving the database.

Examples of each of these, together with an indication of the distribution in each of the two databases in given in Table 14.

Database items as an indicator of critical and creative thinking	**That's Life?**	**Insight on a Site**
total number of different items proposed for the database	77	200
number of items which routine	60 (78%)	130 (65%)
examples of routine items	gets bigger; uses food; movement; can multiply	is there water; do you eat meat; are your days longer
number of items which are sensitive to context	11 (14%)	48 (24%)
examples of sensitive to context items	responds to stimuli; uses telepathy to communicate	is money used; ever been to Earth ; do you have schools
number of items showing 'advanced thinking'	6 (8%)	22 (11%)
examples of 'advanced thinking' items	shows signs of learning; has a capacity for change	do you believe in other worlds; do your tides turn; have you overcrowding

Table 14 *Distribution of items in databases for STARS Trek tasks.*

The large difference in the total number of suggestions made by the pupils may not itself indicate a development of thinking skills as both the context and the level pupil interest could have contributed significantly. What is more revealing is the moderate increase in the total number of items which fell into the two categories of being sufficiently innovative to be noticed. This rose from 22% in the That's Life? database to 35% in the Insight on a Site database. Taken with the general trend of the development of thinking skills, this might again give a reasonable indication of some learning gains in thinking skills for the children in the project.

Comments from the pupils about their own perception of their gains by the end of the project also presents an encouraging picture. In Table 15, are the numbers of children's replies to the question,

How much do you think you have improved in your critical and creative thinking?

quite a lot of improvement	:	31
some improvement	:	4
little or no improvement	:	2

Table 15 *Number of children claiming improved thinking skills.*

Some of the replies were from individual children and others were group responses from a whole school. The general picture, however, indicates a significant perceived gain. This picture is supported by the teachers who reported the thinking skills which their pupils had used and what they thought were the significant areas of improvement in pupil learning. This is summarised in Table 16.

thinking skills used	learning gains shown
planning experimenting modifying reaching conclusions exploring possibilities comparing ideas looking at evidence making decisions checking and changing decisions using trial and error making drawings using tables brainstorming reasoning employing logical techniques refining working systematically being logical acting out making models using sketches and notes using trial, check and improve involved in lateral thinking reflecting on their solution guessing critical and creative thinking communicating effectively discussing and arguing	techniques of planning and experimentation more aware of others' points of view aware of other possible solutions more confidence in problem solving see range of strategies they can use problem solving skills improved communication skills much improved organising methods of problem solving increased confidence to work with minimal supervision good discussions sharing tasks deciding on strategies for problem solving some very good team work

Table 16 *Teacher reported pupil thinking skills and learning gains.*

Comparing the information in Table 16 with that presented in Table 7 shows some interesting similarities and differences. The list of the thinking skills which the children used, and that of the critical and thinking skills identified while creating the Stars tasks have around 10 terms in common. It is likely therefore that what was planned actually occurred. That there are other terms used in the teachers' list (such as acting out, refining and discussing and arguing) could also be interpreted as the teachers not just reporting what they perceived the project aiming for, but that the pupils' involvement was actually meaningful in 'normal' school terms.

Similarly, with the teachers' judgements of pupil learning gains, presumably based their own understanding of pupils' thinking skills, there appears to be some confirmation of success in this aspect of the Project.

4.3.2.3 Gains in collaborative learning skills

The collaborative nature of the STARS tasks was expected to operate in two settings. First, when tasks were sent to the participating schools, the team of pupils in any single school would normally work together at some stage to find a solution to the task set. The earliest tasks were stand alone tasks and were designed so that second level of collaborative learning involving children from several schools, was not emphasised. Sharing solutions was encouraged and the project team assisted through commenting on the replies from individuals and from schools in a manner that drew attention to the suggestions of others. Some of this involved inviting the pupils involved to look at or think about the replies of the others to see if they might want to change their own original suggestions.

Collaboration in a more structured and more involved fashion was to follow when the schools were set into groups based on the STARS Trek roles.

The collaboration which was expected to take within each school varied quite a bit, probably due to such factors as number and age of children involved, classroom opportunities for collaborative work and the extent of previous experience in working together rather than individually.

One indication of the outcome of increased co-operation is the number of shared or group responses, compared with individual responses, to the STARS tasks. Some information from a selection of schools for STARS1, STARS5 and the STARS Trek Egghead task, is summarised in Table 17.

This shows a comparison, in columns two and three, between two of the stand alone tasks, one

at the beginning (STARS1) and one about half way through (STARS5). The final column refers to one of the later STARS Trek tasks where inter-group collaboration was expected to follow from completion of the initial stage of the work, which had taken place, usually individually, in each classroom.

school	different replies to STARS1	different replies to STARS5	replies to STARS Trek Egghead
A	5 individual replies	6 individual replies ("we all worked together but we had different ideas")	a single group solution from 7 children
B	4 individual replies	a single group answer from 3 children	a single group solution from 5 children
C	2 group answers	a single group answer from 6 children	(did not submit)
D	3 individual replies	7 separate replies from 4 children	a single group solution from 4 children
E	2 group answers from 4 children	a single group answer from 5 children	a single group solution from 3 children

Table 17 *Sample spread of individual and group responses to Stars tasks.*

The trend indicated in Table 17 supports a developing move towards pupil activity directed at a single, shared outcome to the problem solving tasks, from the earlier tendency to work individually.

Of the two formats for collaborative learning, in each school and between a group of schools, it is very likely that most pupils will have experienced many examples of the first prior to their involvement in the STARS Project, but few if any examples of the second. The arrangements for the second were, therefore, a significant part of the effort of the project.

Using FirstClass, there are three ways in which the participants can share written communications. One is through posting a message within a conference. This was the principal method which the pupils in the STARS Project were expected to use for all solutions and suggestions for each of the tasks. Every participant has the same access to these conferences and in the STARS environment there was separate conference for each task. This helped to make locating and reading relevant postings simple and quick.

In addition, each school had its own MailBox address (two actually, one for the pupils and a separate one for the teachers) so that the pupils from each school could share their suggestions with a single other school or a selected group of schools. This enabled the schools

in each STARS Trek role group (usually 3 schools per group, 6 for combined groups), to communicate only with those which were appropriate for the task in hand.

The third means of communication was the synchronous, online chat facility whereby schools could exchange messages in real time through typing short comments on screen and sending them to the others engaged in the chat. Several schools could be engaged in the same real time exchange.

Of these three methods to promote pupil interchange of ideas, suggestions and solutions to the STARS tasks, the most widely used and most successful was the suite of FirstClass conferences. Difficulties with the chat facility were usually associated with the problem of arranging schools to be online to FirstClass at exactly the same time. In addition there was no permanent record of the content of chat exchanges, therefore pupils were not able to read these messages again on later occasions and so use them as a meaningful learning resource.

This means that most of the interschool collaboration functioned through the use of the conferences and the MailBoxes. In many instances this was very successful but there were some difficulties in encouraging certain schools to reply as quickly as the initiators of a message or suggested solution to a problem, would have liked. This was identified, by pupils and teachers alike, as being the only constraint to the increased collaborative learning at interschool level.

Despite this, the comments made by both these groups indicated that noticeable progress had been achieved in this area of the Project's focus, as indicated in Table 18.

school	teacher comments on gains in collaborative learning	pupil comments on gains in collaborative learning
1	more aware of other points of view and possibility of other solutions	have to explain very clearly if other people are going to understand what you mean
2	a more confident approach	
3	communication skills increased, aware of difficulties in communication with other schools	help other people by sharing ideas; in a team is not as hard as it would be on your own.
4	communication skills greatly stretched; working co-operatively took a jump forward	working together wasn't as hard as working alone; It was fun too!
5	increased confidence	it's fun working with people you don't know
6	children did not enjoy the exchange of information	be sensible and stick to the subject
7	improved discussion; tolerance of others opinions, sharing of tasks	get more information from other people and we share ours with them

8	team work; co-operating using skills from the classroom with a practical purpose in mind	team work can help you make new friends; it pays to work together
9	working co-operatively together to solve a task	be patient and wait for them to reply; make sure our answers and replies are clear and not misleading
10	older pupils introduced techniques of planning to younger pupils	
11	difficult to measure	got lots of ideas from other schools
12	encouraged less confident children	work together better; easier in the classroom than with other schools; if one person has a good idea other people in the team can help make it better
13	confidence greatly improved in communication	learned to co-operate and how to work as a team; is fun to work as a team
14	skills in communication with others have improved	learned to be more patient with people; learned to work with people and to keep my voice down.

Table 18 *Summary of teacher and pupil comments on gains in collaborative learning.*

Although there were a few schools which did not identify an improvement in collaborative learning skills arising from the STARS Project, it seems reasonable to conclude that the learning environment provided can make a significant contribution in this aspect of classroom experience.

4.3.3 Able pupils

When the STARS Project was initially suggested, the intention was to focus substantially on the learning environment for able pupils in rural schools. Early contact with the schools and the Education Authorities indicated that this approach should be broadened so that a wider range of pupils might participate alongside those identified as able. The selection of the children to tackle any task was therefore left to the class teacher to decide.

When the project drew to a close, the teachers were asked to reflect on how appropriate this earlier decision had been. Every school replying indicated that this had been the correct decision and gave as their supporting reasons for this, the following

every member of the group achieved success regardless of their abilities

it meant other children were encouraged to participate

would have caused friction between those selected and those not, if only able pupils

helped to give some pupils status in the classroom

able pupils did not always contribute the most or the best answers or suggestions

all pupils were able to take something from the activities at their own level

able pupils were able to take other pupils with them

gave the able pupils a chance to lead or direct

allowed an acceptable size of working group to be formed

not keen to reinforce the idea of able pupil for his sake or that of other class members

nothing should be restricted due to pupils' ability.

Notwithstanding the widely held view that all the pupils should have the chance to participate and in the main did benefit from their involvement in the STARS Project, an effort was made to identify any special gains derived by the able children in the sample. The teachers were therefore asked to identify what particular gains these children made and what special roles they might have adopted during the STARS tasks. This is summarised in Table 19.

gains shown by able pupils	number of times mentioned	roles adopted by able pupils	number of times mentioned
problem solving skills	5	act as leaders	5
logical thinking skills	5	co-ordinated ideas	3
enhanced IT skills	4	manager	3
creative thinking skills	2	trouble-shooter	2
decision making skills	2		
help others	2		
part of a wider group	2		
communication with peers	1		
increased confidence	1		
responsibility for own learning	1		

Table 19 *Gains and special roles of able pupils in the STARS Project.*

Although there is no certainty that these gains for able children as shown in Table 19, were solely from the involvement in the STARS Project, there is at least a reasonable chance that some these benefit has accrued. The teachers reported that on several occasions, the able children in their classes were over taken or out performed by individuals (presumably the most able pupils) in other schools. The extent to which this happened is not rigorously documented but it does serve to indicate the fundamental value of a cross school collaborative learning environment, such as that in the STARS Project, for stimulating able children.

In addition, the Project offered the opportunity for able pupils to interact with another adult in the learning environment. In many instances, the able child in the small rural school has contact with only a single teacher for the majority of his time in the Primary school. The importance of the introduction of another adult in a challenging learning environment for these children was recognised by all of the teachers in the project.

A further issue raised by most of the teachers in connection with meeting the needs of their able pupils was an willingness to readdress the provision for such pupils in the context of the small class. This aspect of teacher development is examined in the following section.

4.4 Professional Development of the Teachers

Because the schools in the STARS Project were all rural schools and therefore were generally small, there was normally only a single teacher involved with the children involved in the Project. In a very few instances the teacher changed at the end of one school session in June 1996 and a different teacher took over for Phase 2 starting in October 1996.

The aspects of teacher professional development which were addressed in the STARS Project were in terms of their ICT skills and their concern for wider pedagogical issues. Additionally, in this section, is a report of the specific aspects of teacher mediation in the children's learning as a result of the STARS learning environment.

4.4.1 ICT skills

The teachers exhibited a wide range of ICT expertise at the beginning of the project and, for most of them, the use of the computer for interactive communication outside the school was relatively new. The STARS Project set this interactive communication within a pupil learning environment thus producing a greater demand on the teachers.

All the teachers involved and particularly those who were relatively new to the use of a computer for interactive learning, found that they had to spend some time familiarising themselves with the technology. There were also some problems getting the technology to work and some schools experienced difficulty with modems, usually because they operated at a slow speed, though occasionally because of other technical difficulties.

The promotion of teachers' skills, knowledge and awareness of information and communications technology was therefore important in the STARS Project. A summary of the teachers' reflective views on the contribution of the activities in the project to their

professional development is given in Table 20.

school	professional development gains	effect on teaching in the classroom	views on ICT as a medium for learning
1	more aware of opportunities	problems of hardware being in another room	opportunity to communicate with other children but need more than one phone line
2	know more about problem solving	better computer skills, but needed more time	excellent tool for learning
3	IT expertise has improved; use of e-mail now commonplace	more careful to differentiate for each stage in the class	outreach to wider world;excellent medium for providing relevant & interesting context for learning
4	better IT skills	time needed was more than expected	problems if schools use different hardware; vital experience in real communication
5	increased familiarity with IT and e-mail; enthusiasm for more open/distance learning	improved differentiation; increased emphasis on IT	has potential but difficult to persuade others it is more than a gimmick
6	more confident in using FirstClass	quite a trying time	FirstClass is wonderful, logical thinking and contact with others was a great combination
7	increased IT skills; more able to step back	better at problem solving, discussion and differentiation	could be very successful, but expensive
8	see the potential of the modem	worthwhile experience for the children	excellent medium but requires planning and co-ordination; expensive
9	successful use of e-mail	place of e-mail in the curriculum; widening of educational experiences	very good medium; sharing tasks makes pupils think
10	more comfortable with e-mail; gained in knowledge and skills	could have done with more local support at the beginning	could be used well as a medium
11	none	added additional burdens; unrealistic demands on the teacher	not that friendly for pupils
12	more aware of the child as self evaluator	fulfilled IT and problem solving aspects of work	good motivation for pupils; communication with other schools
13	problem solving; use of critical and creative thought processes	addressed curriculum for problem solving and language skills	widens children's horizons; able to work as a group
14	IT skills have increased; greater interest in teaching thinking skills	incorporated into own teaching plans; heavy teaching load	FirstClass has promoted learning in the classroom; reduces sense of isolation for teachers

Table 20 *Summary of teachers' comments on the influence of the STARS Project on their ICT knowledge, skills and understanding.*

It was clear that the support provided by the project was used differently by the teachers; for example, some were less inclined to 'explore' beyond the basic facilities provide by the conferences on FirstClass. The opportunities for teacher exchanges (STARS:Staffroom conference) were used very little and some teachers felt it an achievement to be able to send mail to others in the project using the MailBox.

In certain cases the very real problem of wanting to discuss a technical issue with project staff by telephone while the computer was linked to the FirstClass intranet was impossible for several schools where there was only a single telephone line. These teachers were unable to use the telephone and the modem link to the FirstClass server at the same time.

From table 20 it appears that despite a recognition that the "learning curve was at times very steep", there were overall benefits in terms of their enhanced knowledge, skills and understanding. Only a single teacher claimed no professional gain. In general the teachers reported a considerable increase in ICT usage, by themselves as well as by their pupils, and a realisation that the computer is a learning tool not an "add on".

4.4.2 Pedagogical Issues

As well as addressing the professional development of teachers in the technology area, the STARS Project team was aware from the outset that some more pedagogical issues were central to the thrust of the whole undertaking. The most apparent of these rested with the early decisions to target able children; to use a problem solving task environment; to focus on the skills associated with collaborative learning and critical and creative thinking; and to use a computer managed medium to promote a distance learning environment.

That these were also the issues seen by the teachers is supported by the comments in Table 20, where the professional development gains mentioned, in addition to those associated with ICT, are

- problem solving
- open or distance learning
- critical and creative thinking
- teaching thinking
- differentiation.

The extent to which the teachers promoted their own development in these areas lay within the scope of the STARS Project to only a limited extent. The STARS:Classroom conference was provided to allow teachers to exchange comments freely amongst themselves. During the first 4 months of the Project there were 40 messages posted in this conference but none of them related to any of the pedagogic issues - there were all chat type exchanges or related to the evaluation forms sent to schools by the external evaluators.

The other opportunity for teachers to share professional views on these concerns was at the seminar for teachers and Education Authority staff involved in the project. This took place in September 1996 and the issues which received most attention were critical and creative thinking and teaching thinking. Ideas about differentiation were also part of the discussion but mainly in terms of a heightened awareness of what teachers felt they would like to do in regard for their more able children.

The issue of able children in remote schools produced less debate than was expected. Virtually all teachers (supported by their Education Authority advisers) very quickly reached the position that identifying able children was not a serious problem but that a programme of work which separated them from the rest of their class would be. There was little exchange between teachers or with the project staff about what the identifiers of able children should be. All the schools in the Primary sector, involved a group of pupils for the STARS tasks which included their able pupils but also others, usually from the older age group. In the Secondary schools the groups chosen were seen as 'able children', presumably as a group, rather than specifically identified individuals with other members of the peer group.

The expression of an interest in critical and creative thinking and in teaching thinking more generally, is warmly welcomed and it is encouraging to note that some of the teachers have expressed an intention to promote their own involvement in this area. Similar expressions of interest in open and distance learning give support to the view that the teachers involved in the STARS Project have become more positively attuned to the use of information and communications technology in an interactive fashion.

Perhaps in a small way the STARS Project will have made a contribution to some teachers beginning their own development as collaborative and critical learners. The teachers' involvement within the collaborative learning and thinking skills aspects of the project may have given some a view of "the immediacy and practicality of such classroom issues and their own understanding of them" (Smyth, 1991) which often leads to personal and professional development.

4.4.3 Teacher mediation

A more specific focus was given to the role of the teacher as a mediator in children's learning and the teachers were asked to take particular note of their involvement in this role.

The evidence for teacher mediation was, like much of the other information collected, reliant on teacher reports. The most common descriptions given by teachers about their role in mediating children's learning were

adviser	overseer
initiator	facilitator
provider	discussant
monitor	consultant
supporter	co-ordinator
explainer	organiser

Most of these terms are consistent with teacher mediation as it is part of the current view of independent learning and pupil autonomy in learning (Doyle, 1986; Bennett and Dunne, 1992). Johnson and Johnson (1994) suggest that "the teacher's job begins in earnest when the co-operative learning groups start working".

The reports from the teachers are confirmed by video recorded evidence (the STARS video) that their role increasingly became one where they were able to help children take the initial steps when working on one of the STARS tasks and then be able to stand back and observe their pupils academic learning and interpersonal skills.

One of the teachers who was included in the video recorded sessions commented, that the making of the STARS video additionally helped him,

> *"..when the video was made I was able to stand back and observe the interaction.."*

Even without the help of a video recorded session, this form of teacher mediation in the pupil learning environment presents the teacher with the opportunity to observe children's learning in either a structured or a more general fashion. This was recognised by several of the teachers, one of whom suggested,

> *"I feel more able to present a learning situation to the children and step back from it , recognising when intervention would be valuable."*

The actions which the teachers might have taken were dependent on all the normal factors contributing to teacher-pupil interactions in a learning situation. Some of the activities which the teachers reported in interviews, relating to their mediating role were,

getting contributions from all pupils in the group

recognising the worth of each contribution

explanation of terminology

one person talking at a time

helping and guiding discussion

comparing suggestions

get them to think logically

encouraging new strategies in problem solving

Much of this support for pupil learning laid considerable emphasis on pupil self evaluation. Nisbet and Shucksmith (1986) have suggested that children's learning strategies which encourage them to be come self evaluating pupils are some of the most effective for learning gains. The strategies suggested include recognition of the goal (or problem), identification of strategies to achieve the goal (or solution) and the ability to evaluate progress towards that goal. All of these have been obvious in the STARS learning environment and may allow the project some claim to having encouraged independent and successful pupil learning.

4.5 The Systems and the Technology

When the STARS Project was initially proposed the decision was taken to attempt to explore the distance learning environment without the installation of expensive or completely new equipment. The schools used what was already available to them in terms of hardware. Some schools were provided with a modem by their Authority but this was normally part of Authority planned provision.

The software for use of the FirstClass system and that for access the World Wide Web were provided by the Project. Documentation for the use of these was also provided along with any backup assistance or advice through appropriate staff of Northern College and the respective Education Authorities.

4.5.1 Telephone communications

The telephone communication link with the FirstClass server in Northern College was the means of the electronic communication used in the STARS Project, this including the access to the WWW for those schools also involved in that aspect of the activity. None of the schools had ISDN lines and many had only a single telephone line into the school.

There were some problems with having only a single telephone line as those schools had to detach the telephone to be able to link to the FirstClass network. There were two difficulties which this posed. One was that some schools were unable to seek advice or help by the telephone and have the link to the FirstClass server at the same time. This sometimes made explanations and advice harder to follow and certainly made the process of helping teachers more protracted and slightly less 'user friendly'.

The second problem was associated with the restriction on the use of the telephone for more conventional purposes while the link to the FirstClass server was in operation. Particularly for remote rural schools, the use of the telephone for contact with parents, and staff of the Education Authority is seen as a vital and essential 'lifeline'. Many of the schools therefore felt that it was not feasible for them to monopolise the telephone line with the computer related work for long periods of time or at times of the day when conventional use of the line might have been expected by those outside the school.

Although the contact with the FirstClass server was at local rate charges for all the schools, protracted periods of use of the telephone was expensive for small rural schools which had quite small overall budgets. With most schools moving to a form of devolved financial management, there were mixed opinions about whether this was a benefit or a disadvantage in terms of covering much larger telephone costs than might have normally been expected.

By the end of the Project the schools had devised their own means of reducing the amount of time spent using the telephone for STARS related work. In the main this involved doing most of the work offline and it was anticipated that if a newer version of FirstClass were to be used, this process would become simpler and more commonplace.

4.5.2 Appropriateness of FirstClass

The FirstClass system has three means of communication; by conferences, through e-mail using the MailBox and by synchronous chat with others online.

During the early stages, the schools in the Stars Project found that there were some occasions when their pupils were engaging in chat sessions with other FirstClass users not on the STARS intranet. This raised some questions in a few teachers' minds about the appropriateness of such conversation and their cost in terms of telephone charges. The teachers seemed to find ways to exercise some control.

> *"One of the boys found ... the chats exciting (this may have something to do with a lengthy chat with a fellow Rangers supporter, till 'miss intervened')"*

"Chat facility is helpful and children look forward to them, but .. had to ration the amount of time".

The MailBox facility which was established, allowed any teacher or any group of pupils in any project school, to send a communication to all the schools (intended for teacher access only), all the groups of pupils (intended for pupil access) or both, or any individual member of either group. The disadvantage of using the MailBox facility rather than posting a communication in a FirstClass conference was that unless members of the project team were specifically included by name, the exchanges would not be available to them.

The extent of the use of MailBoxes, for an individual school (teacher) or group of pupils, can be verified only by the Administrator of the Northern College FirstClass server. Each MailBox user can also delete any unwanted messages after they have been sent and therefore there is no completely reliable indication of MailBox usage. Best estimates would suggest that the pupils in any one school on the STARS Project sent somewhere between 20 and 40 messages to other STARS participants (including the project team) and perhaps the same number to all the STARS conferences.

The teachers who made comments about their use of the MailBox varied in their opinion about its value. At the mid way stage of the project, four indicated that they thought the MailBox was "useful", "very helpful", and "more convenient than post or telephone". Three teachers were more of the view that the MailBox was "more handy for the organisers than myself", "some messages were unnecessary", or were "confused by all the different routes".

The success of an intranet system such as that used in the STARS Project depends in large measure on the co-ordination of the interaction between the participants. A summary of several such studies suggests that "one of the factors for success is the amount of attention paid to the human, non-technical aspects of the messaging system" (Burger and Farragher, 1995). In the STARS Project, members of the team were heavily involved keeping the interaction going. Sometimes this was at the level of a telephone call to a school to assist in meeting deadlines,

"I was grateful to be rung up and reminded about things"

and on other occasions it was to assist schools in their attempts at setting up synchronous exchanges using the Chat facility. Most of co-ordination was the daily task of providing feedback, answering questions and encouraging schools to maintain the project's momentum. This was a heavy workload and required almost daily availability of one of the team, who had

sufficient knowledge of the project or with easy and rapid access to specialist advice or support, if required.

4.5.3 Video conferencing

Although the major emphasis of the work of the STARS Project was intended to use the equipment and applications of ICT which schools already had access to, there was the intention to look at some of the alternatives which might become more widely available in the near future. It was therefore intended to explore some of the possibilities with video conferencing and the World Wide Web.

The schools themselves decided that work in these two areas should be voluntary and in addition to the ongoing mainstream STARS activities. From those volunteering, two schools were selected for the videoconferencing trial. Attempts were made in each of these two schools to install inexpensive video conferencing hardware and accompanying software. The medium for transferring the electronic information remained the traditional telephone line. The initial trials provided a very poor access to video conferencing, at such a level that the trial was abandoned.

In the judgement of the technical staff involved in this aspect of the project, it was clear from trials that high speed internet access was required to implement a video conferencing facility of sufficient quality to be of use in schools. This facility was not available through the conventional telephone line installed in the STARS Project schools.

4.5.4 Access to the World Wide Web

There were 4 schools, two at the Primary level and two at the Secondary level, in the subsample attempting the WWW task.

A web site for the STARS Project was prepared and was used initially for the schools involved in the WWW task. It was later to develop a wider remit to be of interest to anyone with access to the World Wide Web. The location is

http://www.norcol.ac.uk/stars/

Instructions for the use of the Web browser supplied to the trial schools along with details for accessing the STARS web site, were specially prepared for the project.

In preparing the WWW task the project team tried to take account of the suitability of material available to the pupils, some restriction on wide-ranging 'surfing' and a minimum cost to the schools for time on line. This was addressed by creating a task which required

some shared structuring of the task to be completed. To achieve this the pupils had to work out together, before searching the web pages, fairly precisely what they were looking for. Links to the pages selected for the task were located on the STARS web page (along with several other related pages but not those which would immediately provide the information for the STARS WWW task). In this way some restriction to 'surfing' was created, although it was impossible using the real time connection, to prohibit this completely.

The evaluation of the WWW task is based on the responses of the four school involved but does show some encouraging findings. The comments about the Stars web page were positive.

"The Stars page and Launchpads were excellent"

The degree of structure built in to the WWW task also appeared to appeal to the teachers and the pupils themselves saw the advantages as well as the disadvantages of the way the task was implemented,

"It gave us a format to work with"

"The pupils in the other school were reluctant to see past their own ideas which made this very difficult"

With regard to the potential of the use of the WWW in classroom learning, all of those involved held a largely positive view,

"I think that the potential is enormous"

"Good, but time consuming and requiring specialist equipment"

"Amazing potential"

"The children took the technology for granted"

The possibilities of the WWW in the classroom are beginning to receive considerable attention and successful means of achieving an appropriate learning environment are beginning to be reported. Heide and Stilbourne (1996) suggest that there are possibly four different ways using the WWW to enhance learning; through connectivity, through online resources, by becoming involved, and by learning to learn. The STARS Project WWW task mainly involved learning through online resources although the possibility of using the Web to present the problem solving tasks might have been a challenging alternative. Further exploration of this must be tackled in a fresh undertaking.

4.6 Summary of outcomes and links with underlying theory

The main outcomes from the Stars Project can be summarised as follows.

- It is possible to provide a suitable learning environment in remotely located schools using a computer based intranet such as that provided through FirstClass.
- Access to the World Wide Web to aid pupil learning in the classroom is generally welcomed by teachers but access has to be through relatively high speed modems.
- Problem solving, particularly if it extends beyond the field of mathematics, is an area which teachers were happy to see emphasised.
- Effectiveness of an interactive learning environment was noticeably enhanced by frequent reinforcing comments by the Project staff, to pupils on their efforts in finding solutions to the tasks.
- Both pupils and teachers improved their ICT skills, for some from a minimal starting point.
- Positive features of the learning environment which were consistently reported and which link with the theoretical basis for learning on which the Project was based, include

  motivation from the learning tasks themselves (Feuerstein)

  pupils listened to each other and respected their contributions (Lipman)

  children were more aware of themselves as learners (Feuerstein)

  adjusted their own ideas and concepts (Lipman)

  increased their problem solving skills (deBono)

  evidence of significantly increased discussion (de Bono, Lipman)

  significant move from individual to group work in the classroom (Lipman)

  problem solving became more systematic (Sternberg).
- There were some learning gains in critical and creative thinking skills.
- Collaborative learning skills developed from their successful application with a single classroom to interactions with peers at a distance.
- There are difficulties in maintaining interschool collaboration because of differing classroom demands and priorities.
- Able pupils have special gains from distance learning work of this nature, in problem solving and logical thinking skills including an awareness that sometimes others would out perform them.
- Able pupils in this learning environment adopted special roles as leaders and co-ordinators, taking greater responsibility for their own learning.
- Support for teacher development through online advice and instruction was largely successful. The need for a more specialise support via the telephone or in person remained for specialised instances such as gaining access to the WWW.
- A significant number of teachers reported a fresh professional interest in teaching thinking, differentiation and distance learning.

- Teacher mediation in pupil learning in the problem solving environment is consistent with widely used practices for the promotion of pupil independence in learning.
- Pupil self evaluation was apparent as a significant and valuable part of the learning environment provided and supports a constructivist approach to learning.
- There was a consistently high level of interest, motivation and industry from both teachers and pupils throughout the project and most would welcome a continued involvement.
- The maintenance of an intranet system for effective classroom learning depends, in some measure, on an element of external co-ordination.
- Video conferencing at an acceptable level for meaningful classroom interaction can probably not be achieved using narrow band telecommunications.
- It is possible to create a structured environment which allows meaningful, creative and motivating use of the WWW for classroom learning.

5 Funding and Project Promotion

5.1 Support and Sponsorship

Prior to the reorganisation of the Scottish local authorities on 1 April 1996, the Authorities involved with the STARS Project were Grampian, Highland, Orkney, Shetland and Tayside. At the close of the project early in 1997, this had changed to eight Authorities; Angus, Aberdeenshire, Highland, Moray, Orkney, Perth and Kinross, Shetland and Western Isles.

Initially the Authority staff involved in the STARS Project were from the Directorate and Advisory services. They were wholly responsible for the selection of the schools to be asked to participate and to help put into place any required equipment and support for these schools to be able to participate.

Many of the Authority staff taking the decisions in these early stages continued to make a major contribution in the project's Advisory Committee and in the subgroups preparing the learning materials.

The support provided by the Authorities was sustained throughout the whole of the project in several ways. Authority staff responded to requests from their own teachers and from projects staff to assist in the resolution of minor technical issues normally in relation to communication difficulties between schools and the Northern College FirstClass server. In all but one of these cases (Daviot Primary School) the issues were resolved. In some instances the Authority response was particularly generous in providing additional facilities to the school in addition to those which were the basic requirement of the project.

The Authorities' support was most noticeable in their encouragement to the teachers involved (and to the project staff), to continue with the project throughout the whole of 1996 and a little beyond into 1997. This awareness of the Authority's approval helped sustain the project at times when it was clear to everyone that the demands were great. It was evident from the start of the project through to its end, that co-operation was willingly given and requests for pupil responses and teachers' comments were never refused.

Sponsorship was also supplied by all the Authorities involved to provide a Project Fund of £1250. In addition, the video company AVC donated £3000 for video preparation in connection with the project. This supported the production of a STARS video for use in the promotion of the project's outcomes and potential wider application.

Further sponsorship of STARS came from Northern College. The three project co-directors were members of the College's staff drawn from the Primary Development, Educational Studies and Computer Education Departments across both College campuses. Part of their time was allocated to the project along with support from other members of the lecturing and technical staff (particularly programmers, technicians and research staff).

In addition the College allocated between £8000 and £10000 of its support budget for studio and onsite production of video recorded material. This was used to produce new video recorded material for use with the STARS Trek tasks and a promotional video which became known as 'the STARS video'.

5.2 The STARS Video

The video introduces the viewer to the 'STARS Experience' through examples of children tackling four of the tasks which were part of the programme ; Bouncing around, Police line up, Egghead, and Earthfile. It also shows two head teachers from the participating schools talking about the teacher's role in the STARS learning environment, how the able child had particularly benefited from the project, the value for all children of the focus on thinking skills, the curriculum links more widely in the classroom and communication skills. The video finishes with short excerpts from children giving their own views on what they thought about the STARS Project.

The STARS video runs for 27½ minutes and the main areas of focus, through examples of children working on the STARS tasks are,

- thinking skills
- communication and collaboration skills
- ICT skills
- links with other areas of the curriculum
- teacher's role

5.2.1 Thinking skills

The role of thinking skills in the STARS Project is introduced in the video. In the earlier stages, the focus is at the more general level in relation to critical thinking, creative thinking, communication and collaboration. A more specific approach is then adopted through the identification of the particular skills associated with some of the tasks.

In the Bouncing around task the importance of accuracy and consistency in making observations and in taking account of all the factors involved in solving a problem, are highlighted. Mention is also made in this context of making and testing hypotheses, and the interpretation and evaluation of test findings.

These latter two, interpreting information and checking conjectures against evidence provided, are also identified in the Police line up tasks. In addition, opportunities are suggested in the context of this task, for promoting the different skills of identifying the nature of the problem, deciding on a plan of action and representing information in a physical model, particularly where it illustrates the importance of visualising a problem to assist the finding of a solution.

Planning and the organisation of ideas is presented again in a different format along with the role of creativity in Egghead task, while in the context of the World Wide Web related Earthfile task, the role of critical thinking is described in some detail.

5.2.2 Communication and collaboration skills

There are several on-screen examples of children collaborating in the classroom and mention is frequently made of the interactive collaborative role of the computer in permitting sharing among pupils in different schools. The different forms of this co-operation illustrated in the video are

- working with teams of five other schools to submit a composite report on the findings of an investigation (Bouncing around)
- sharing and gathering information before a task can be identified or solved (Police line up)
- creating messages and instructions to be interpreted and followed by pupils in other schools (Egghead)
- using the criticism and suggestions from other pupils to change and improve their own ideas (Egghead)
- negotiating a shared set of criteria for a learning task before embarking on it (Earthfile).

5.2.3 ICT skills

The video draws attention at various points to the skills which the pupils in the STARS Project have practised in information and communications technology. Mention is made of the basic operating skills of starting up and closing down computer systems, using floppy disks and a modems, as well as keyboard skills and the use of a mouse. Additionally, there are illustrated examples of word processing; information handling through databases; sending electronic mail and the complex skills involved in processing information for inter school communication.

A specific reference is made to the exciting possibilities involved in gathering information from the World Wide Web and how the project attempted to make this less time consuming than it might otherwise be due to the enormous potential for distraction from the original task, that the WWW offers in the vast amount of information available to users.

5.2.4 Links with other areas of the curriculum

The success of the STARS Project lies to some extent, in the manner in which it is seen by teachers as having strong links with the ongoing curriculum work of the Primary or Secondary school. To help make the links between the STARS Project and other classroom work, the video makes specific mention of several such opportunities afforded by the tasks. The suggested connections include

- estimating and measuring in Mathematics,
- collecting, presenting and evaluating data as part of investigations in Environmental Studies,
- problem solving in Technology,
- the design process in Technology,
- information gathering skills for all subject areas.

5.2.5 Teacher's role

The two head teachers (one of a single teacher school and the other of a three teacher school and both personally involved in all of the STARS Project) who participated in the video, give a first hand account of how they saw their mediating role in their children's learning. They describe this as initiating, supporting and helping to bring the learning together. They were able to pay more attention to the social learning opportunities to provide or highlight experiences which are not easy to teach in the classroom where there was no computer link with other schools.

There are also some very clear examples on the video, illustrating these head teachers in

action with their pupils in this interactive mediating role.

5.2.6 Dissemination

Each of the participating schools in the project has a copy of the STARS video as part of their own record of their involvement. In addition each of the Education Authorities responsible for these schools has been given an further copy. This dissemination should both assist those involved at first hand with the project to have a more complete picture of its breadth and scope as well as serve to promote the STARS model to all those who have contact with participating schools and Authorities. Already responses from the recipients indicate that both these functions have begun to happen.

The inclusion of the video is now an option within the wider dissemination of the project's findings and reports.

6. Presentations and Reports

As a part of the dissemination of the progress and outcomes of the STARS Project, the co-directors have made presentations at a range of conferences and seminars.

The major events have been

Video and Computer Conferencing in Education and Training organised by University of Aberdeen Vocational Training Unit and held in Inverness between 23 - 24 September 1996. A paper entitled " On-Line Education in Teaching and the Caring Professions" summarised the STARS Project from a perspective of the innovative use of information and communication technologies for children's learning. The paper has been included in the published Conference Proceedings.

Tactics & Trends '96 - Lifelong Learning in a Wired World organised by the Scottish Council for Educational Technology in Edinburgh between 13 - 14 November 1996. This conference was officially opened by the then Minister for Education, at the Scottish Office, Raymond Robertson, and the STARS Project was mentioned in the Opening Address. A workshop was presented giving the background to the establishment of the project and demonstrating the use of FirstClass as the medium for presenting the project learning environment.

Education Departments' Superhighways Initiative Conference organised by the National Council for Educational Technology in London between 18 - 19 November 1996 for all the Projects involved in the Government's Evaluation Programme. A poster session was presented outlining the issues addressed by the STARS Project along with a summary of the interim findings.

IT's A Voyage of Discovery, the annual Microcomputers and Primary Education (MAPE) conference, held in Dundee between 21 - 23 March 1997. A paper entitled "The STARS Project" was presented highlighting the effectiveness of existing and emerging communication networks for the promotion of pupil learning and teacher professional

development.

Rural and Remote Schools: the Continuing Professional Development of Teachers, a British Council seminar on Good Practice in Scottish Rural Education, held in Aberdeen between 6 - 12 April 1997. A paper presented was entitled "Technological Solutions to Improve Interaction" and focused on the value added to schools and the curriculum.

Equity in Education, the SCRE Forum on Educational Research in Scotland, held in Edinburgh on 16 May 1997. The paper presented was entitled "STARS Project - Remote Control Thinking" and focused on the teaching thinking aspect of the project with particular reference to the benefits for able children. Some of the issues relating to the provision of an enhanced learning environment for able in remote settings were also considered.

IT in Education and Training Conference based in San Jose on 21 April 1997. A presentation entitled, "Stars: Extending and Enhancing Classroom Experience" was made by video conference link from the SOEID in Edinburgh, on the STARS Project with a particular focus on the extended opportunities which the project had to offer to pupils and teachers as well as the potential for the development of new partnerships.

Changing Practices and Technologies: Decisions Now and for the Future, the 14th International Conference on Technology and Education held in Oslo on 10 - 13 August 1997. A paper entitled "STARS Project - A few bright sparks?" was presented to an audience with representatives from some of the 57 nations at the Conference. The focus was on the use of distance learning to promote and enhance a learning environment which is consistent with the National curriculum. An abbreviated version of the paper has been accepted for inclusion in the published Conference Proceedings.

The annual conference of the Scottish Educational Research Association held in Dundee on 18 - 20 September 1997. The paper presented was entitled "STARS in Their Eyes' and looked at some of the curricular and teaching issues of using information and communication technologies with a particular focus on the role of partnership.

Other presentations made by members of the Project team include Staff Research Seminars for staff at Northern College and special sessions for students following the BEd course, also at Northern College.

An invited article entitled "Stars Project - shedding a little light?" has been published in the Northern College Biology Newsletter (Ewing, Dowling and Coutts, 1997).

There is the likelihood that the evidence collected from the project will permit the writing of further articles for possible publication.

In addition the Project team has been represented on the Advisory Committee for the Education Departments Superhighways Initiative, Scottish Superhighways Evaluation and has assisted in the preparation of the section of the EDSI final report on the projects in Scotland (DfEE, 1997a).

7. Wider Applications and Opportunities

7.1 The General Picture

The STARS Project has been different from other studies in a number of ways. A contribution it might make to the examination of the use of electronic communications technology in an educational context therefore reflects some of these differences, some of which are outlined below.

The project attempted to explore the use of relatively inexpensive technology by providing links between school which previously did not have such links or in many instances had not even considered having them. Many of the schools selected had not 'promoted ' themselves or asked to be involved in a such a project but rather they were identified by their Authorities for quite different reasons. These schools started 'from scratch' and required to be brought to a level of knowledge and expertise with very little or no previous experience in working with information and communication technologies.

As an example of a sustainable and scaleable development, the project has shown that it is possible to use inexpensive and existing networks for distance learning in rural areas. The resources used effectively were those which existed in the schools at the time of the STARS Project. This approach could readily be extended and enhanced to include a wider group with similar facilities.

The training and support for teachers to enable all of this to happen was concurrent with the development and evaluation of the pupil learning environment. There was no 'set up period' and the success of this project hinged heavily both on the clear perception by project staff of what was required and on the ability to provide teachers with basic training packages with immediate and effective backup.

The project was also different in that it aimed at harnessing the value of computers in distance learning for able children in remote school locations. Although computer managed

or computer delivered teaching material is now extensively used, probably as much with able children as with other learners, there is little evidence of it being employed on a collaborative basis across several schools.

Yet a further difference is that with the STARS Project, the learning environment was largely created and managed by tutors outside the school. Such involvement of other adults, at a substantially interactive level, in the preparation and presentation of the distance learning environment, is not yet widespread.

The project staff decided to prepare much of the material used in the STARS learning tasks and to remain as the major provider of the on-line learning environment, because of the flexibility this allowed for encouraging interactive and collaborative learning with children from different schools. Such flexibility enables due account to be taken of the pertinent local demands on some remote schools whose timetable is sometimes strongly influenced by external controls (such as transport or whole school swimming lessons). None of the material was therefore specific to one school or to the circumstances relating to the unique learning environment of any single school.

The children in the STARS Project had several new roles and relationships to develop and master within the extended learning experiences provided. They had to think about and learn how to communicate to other children whom they could not see yet with whom they could chat through on screen synchronous writing. Additionally they had a "controller" whom they quickly learned was the source of different, and for some, stimulating learning tasks (often with encouraging feedback on their efforts). This additional person outside the class was real and yet different from any most of them had previously met in the school context and it meant yet another set of communication rules.

Co-operative learning across schools is not much practised at the Primary school level and has yet to be fully explored. Because pupils involved in co-operative learning should be participating in the same learning environment at approximately the same time, the role of electronic (and therefore fast) communication is crucial. Collaborative interaction between pupils even with a short time delay would be difficult to sustain without ICT.

The sense of audience which is produced in this interactive experience is widely recognised and valued by teachers in remote schools. What the STARS Project did was not just to provide the opportunity for such interactive co-operation over long distances but to make it a necessary part of the learning environment.

Finally, teaching thinking was the element of the project which was recognised by most of

those participating (teachers as well as pupils) as different from other computer related projects. The production and use of learning material which promotes such aspects of thinking as critical thinking and creative thinking appears only occasionally in the school curriculum throughout Scotland. The STARS Project may be one of very few which have attempted to promote this aspect of children's learning through the use of the electronic media.

The Government's proposals for a National Grid for Learning (DfEE, 1997b) make a strong case for promoting networked learning. This in part will build on the "evidence about the best approaches to teaching and learning with networked technologies". The STARS Project is quoted as one example of such evidence.

The opportunities for wider applications of telelearning opportunities can be seen to fit well with the expectations of the Government's proposals for "securing the benefits of networked technologies for education and lifelong learning".

7.2 Possibilities In Schools

The creation of other electronic communication networks for educational use is now a major priority. The National Grid for Learning proposals include having all schools in the UK connected to the Grid by 2002 (DfEE, 1997b).

In addition to issues related to resourcing schools' participation in widespread use of ICT for learning, the likely concerns which will face decision makers might lie in the areas of the curriculum, professional development of teachers, pupils' learning, and partnerships in teaching and learning.

7.2.1 Curriculum

The cross curricular approach adopted in the STARS Project was seen as important when introducing a relatively new learning environment into which the teachers themselves initially had only a limited input. There are other aspects of cross curricular work which would lend themselves to a similar approach and might include

- investigations
- reporting
- information handling
- oral communication.

In addition, sharing across schools of learning tasks and practical activities could be exploited to enhance the teaching of the more traditional areas of the curriculum, particularly in the areas of literacy and numeracy.

The promotion of bridging between the P7 and S1 learning environments presents yet further opportunities for collaborative teaching and learning. Joint or shared teaching of common curricular or cross curricular areas could be undertaken, as well as some sharing of differing teaching styles and approaches, between the two stages.

The identification of Core Skills in Higher Still may offer yet another avenue worthy of promoting a network based interactive collaborative learning environment using a model based on the experiences of the STARS Project.

7.2.2 Professional development of teachers

Few teachers would deny that opportunities for personal and professional development would help them develop in three ways,

- their skills, knowledge and understanding of the use of electronic communications technology
- a professional evaluation of appropriate curriculum applications of ICT
- an awareness of the associated pedagogic issues.

The teachers in this project agreed that they had benefited professionally from it by developing technical skills in relation to electronic communications and in promoting their own thinking about how the technology might be used in other work. It was through being part of a project like STARS where the teachers were involved in the practical application of new ideas, that much of their professional development took place.

The consistency with which the teachers reported their gains in professional development must lend some credence to schemes of this type being largely successful in other planned programmes of Further Professional Development. Such use of ICT should be seen as a key way of supporting teacher development to improve their own understanding and expertise.

The implication of this is that proposed or planned innovations using electronic communications technology could have a well defined training element, addressing perhaps each of the three areas indicated above. The employment of practical applications of this nature in a training as well as a development role, could also apply in the initial training of teachers.

Few would disagree that teachers themselves must take some initiative and responsibility for their own development, but it may rest with the supporting and training authorities to help by encouraging ICT based learning opportunities, through the specific promotion of network based learning environments, like that used in the STARS Project. Training programmes could be prepared to indicate how these learning environments might be achieved, for use at both pre-service and in-service levels. Promotion of their use as training packages in Europe or further afield, might be a further attractive option.

The pedagogic issues which were part of the STARS Project included the teaching of thinking and problem solving, differentiation (for able children) and the area of open or distance learning. The opportunities for the participating teachers to explore and discuss these issues were part of the planned interaction, without being a stipulated requirement. A more structured interactive environment would be possible and could include a programme of instruction for teachers to explore some of the wider pedagogic issues such as classroom management, coping with change, management of resources or curricular design.

Although these wider aspects of teacher personal and professional development are already part of the provision within Further Professional Development programmes, they might also benefit from a fresh examination in the light of the need to provide training in the use of electronic communications in an educational setting. The examples of good practice in schools or throughout networked groups of schools should provide a valuable resource for sharing interactively using ICT.

In this way innovative programmes for promoting teaching and learning across a wide range of educational settings and environments should be able to promote teacher development in virtually any area of ICT skill, knowledge and understanding, curriculum application or pedagogy, while retaining a wider appeal for all aspects of pre-service or in-service training.

The experience of the STARS Project could serve as a substantial platform for the preparation of training courses which are likely to be in increasing demand if the promotion of ICT in learning and teaching becomes a major initiative in education in the coming years.

7.2.3 Pupils' learning

There have been improvements to children's learning during their involvement with the STARS Project. The evidence from the project suggests gains in ICT skills, thinking skills and in collaborative learning.

Although the project was not designed to make comparisons with pupils not involved in learning associated with the electronic media and allowing for the Hawthorne effect of having given the project children considerable attention beyond what might have happened in a more traditional learning environment, the learning gains were real and generally welcomed by the teachers.

The development of pupils' skills in their use of communications technology in the context of the ongoing learning environment of the classroom is essential for children to understand the potential of ICT more widely. Today's pupils are likely to experience applications of electronic technology whatever work, home or leisure environment they will be in on leaving school. It is clear that all children should be given the opportunity of equal access to such learning experiences as have been provided to relatively small groups in the STARS Project.

Due to the ever increasing publicity and general public awareness of computers and electronic technologies, there might well be a greater expectation from today's school pupils for ICT in education than many schools plan to provide. The promotion of the National Grid for Learning will serve to raise these expectations within the adult population as well.

The project's focus on critical and creative thinking skills was a novel experience in some ways, for most of the teachers. None has subsequently denied its value or contribution to the general learning development of their pupils and some have decided to continue and expand this aspect of their teaching. There might therefore be an opportunity to promote a set of electronically managed learning environments more widely across the Education Authorities, specifically focused at teaching thinking. Consideration could be given to the different approaches or formats of promoting thinking skills in the learning environment.

The interest in teaching thinking is also part of a much wider movement in some areas, one of which is located at the Artificial Intelligence Applications Institute of Edinburgh University (Parry, 1996). This movement promotes teaching thinking skills to children from Primary school through to Secondary school and is already becoming established in some European countries as well as South Africa and North America.

Co-operative learning includes a wide range of interaction and discussion activities all of which are generally held in high regard as part of the learning process. Interaction and discussion in face to face situations are both familiar to most children as part of their day-to-day work in the classroom . Where a limitation of numbers in very small schools or classes makes it difficult for much face to face group work to take place, then ICT provides the opportunity for a new experience, the "virtual group".

Further investigation of the techniques of managing the learning of virtual groups is required. The means of establishing and maintaining successful interactions between such groups is not yet clear. The mechanisms, requirements and supports which will help to make virtual groups operate successfully have yet to be explored.

The STARS Project has begun to explore how the richness already embedded in the variety of classroom learning environments may be further enhanced, for the small rural schools, by introducing the virtual group. This additional layer functioned well in the STARS Project as an adjunct to the successful and stimulating learning environment already in place. It made no attempt to replace normal classroom teaching, but rather served to produce one form of the 'extended classroom'.

The STARS model of the extended classroom featured a significant element of interaction between pupils in different schools in a limited range of learning tasks. A more detailed analysis of this approach seems eminently worthwhile.

The features of the interactive learning environment which need to be investigated might include the structure of the learning task, the applicability of learning outcomes to a wider group, the dependence on reading, writing or talking, the use of drawings or pictures and the role of multi-media resources. Wider issues of the relationship to ongoing curriculum organisation and timing, as well as availability and access to relevant equipment also need to be examined more fully.

The attitudes and personal attributes of the learner as they might contribute to effective virtual group work lie in another area now requiring closer study.

The STARS model presents a possible structure for such investigations as it could be applied to a wide range of distance learning environments covering almost any aspect of children's learning.

7.2.4 Partnerships in teaching and learning

In the STARS Project there have been three main partners in the teaching and learning environment; the pupil, the teacher and the college tutor. Each of these has adopted a variety of roles depending on the nature of the interaction. There have in effect been different types of partnership, even though they have involved some or all of the same partners.

Additionally there has been a form of partnership within the confines of each of the

'partners'. So the pupils as a group have demonstrated aspects of partnership in their own learning, as have, perhaps to a less noticeable extent, the members of the other two groups, the teachers and the college tutors.

A summary of these partnerships is

Pupil partnership

The learning tasks presented opportunities (in the earlier tasks) and a requirement (in the later tasks) for children to share at all stages in learning. They experienced opportunities for promoting their own ideas and for using the ideas of others to modify their own. The concept of an extended audience (within the peer group) was a new element for many of those participating in this partnership. Part of this experience was wanting to know what the others looked like and they suggested (and implemented) sharing photographs of themselves with the others.

Teacher partnership

Within the group of teachers were those who had previous experience with ICT and many who had little or none. Exchanges between the teachers through the FirstClass conference facility indicated common feelings of 'being in it together' as well as gaining from the experience of those who had 'done it before'.

College tutor partnership

The three co-directors came from different backgrounds and disciplines, a psychologist, a former rural Primary headteacher and a specialist in computer technology in education. These three different fields were shared at all times throughout the project and each tutor was able to (and frequently did) call on the expertise of the other two.

Teacher - pupil partnership

While involved on work for the STARS Project most of the teachers saw their role as noticeably different. The teacher was not the provider of the learning task, but more the initiator of children's thinking. The teachers often said they saw their contribution reducing as the children progressed in their learning until the end of a task where they would be involved in pulling it all together. The pupils also appeared to recognise this different approach and usually took the responsibility for much of their involvement. In this partnership there might have been a different kind of mediation in pupil learning than normally happens in the classroom

Teacher - College tutor partnership

In the main this partnership had two elements to it, one where the teachers were

participating in a College directed project and the other where the teachers were engaging in professional development associated with ICT and classroom learning. In the first element, the partnership was one of very willing co-operation, with occasional apologies for falling behind. The interaction was always very friendly with a large amount of professional respect on both sides. The other element often merged with the first and included a large measure of sharing of knowledge and understanding together with a substantial feeling of 'learning together'.

College tutor - pupil relationship

This was a relatively new experience and for some pupils might have been a completely new one. The appearance of another adult outside the school as part of the learning environment played a significant motivating role. The pupils wanted to know what this other person thought of their suggestions and on occasions were greatly disappointed if there was no response forthcoming. This was exactly like pupils looking for approval from their own teacher, only now it was from the "virtual teacher". This was a quite different aspect of the extended audience.

Not very much is known about some of these partnerships, particularly where the virtual teacher is involved and opportunities must now exist to explore these relationships more fully.

Yet further new partnerships could be examined in the context of electronic communication networks with schools, such as guidance and counselling, meeting special educational needs (in addition to those of the able child) and further education and careers advice for school leavers.

7.3 Applications outside Schools

Many of the applications to school learning based on a distance or networked approach could be applied equally well other areas of learning.

Pupils working from home through choice, injury or circumstances, can be provided with professional feedback or can be linked with others in similar situations. Similarly, pupils in the certain stages of the secondary school, may benefit from being given the opportunity of studying at home without the loss of relevant contact with their teachers.

Similar conditions already apply to students in Further or Higher education where it can be cost effective without being educationally impoverishing, to work from a remote location (or

from home), through maintaining meaningful educational interaction with fellow students.

Through extended use of network technologies, pupils in schools can have the opportunity to share experiences with experts in areas which are inaccessible due to safety or are considered to be too expensive to visit or bring into the classroom. Working with animals or farm visits, once a firm favourite with many schools, are now often discontinued for health and safety reasons. Contact with these important aspects of children's education and life experience need not be dismissed but could be strengthened and exploited through electronic links. Direct contact with expeditions, ventures and distant projects is similarly possible through ICT and an educational involvement in such activities is a real, "live" possibility.

In Further and Higher Education and business and vocational training there are already many examples of networked learning. The model used in the STARS Project has shown that such interactive learning can be successful with relatively straightforward resources.

Applications in industry and commerce could cover a wide range of training situations. One certainly worth promoting is the training of thinking skills through distance learning. With the increased interest in the 'learning organisation' in the industrial and commercial sector, short courses on this as well as other aspects of modern management theory might be appropriate and timely.

Refresher or advanced training courses taking place in the workplace are wholly possible and economically viable. Employing learning networks such as that in the STARS Project, providers of such courses or training, could provide the central support to make such activities both successful and enriching by integrating a wider range of workplace experiences that has hitherto been the norm. Bringing together similar concerns from different perspectives is as valuable in the workplace as it is in educational institutions.

Economical training packages, designed to meet the customised needs of almost any market is a real possibility.

8. Conclusions

The overall aim of the project was to demonstrate how learning for pupils and professional development for teachers can be enhanced by the use of multimedia resources made available over existing and emerging communications networks.

The selected strands of the study were to report on strategies to support isolated able children; distance learning applications involving collaborative learning and creative and critical thinking; using ICT to deliver relevant and effective training and professional development for teachers; and exploring how a network using existing technology might be developed.

The aspect of the study looking at making provision for the learning needs of able children was extended to include all children chosen by their teachers for inclusion in the project. Thus the sample included children identified by teachers as able as well as children from a wider range of ability.

This report has detailed some of the gains made by all of these children and the specific gains observed in the able children. An interpretation of the evidence presented suggests that the format of the project has presented a set of circumstances producing learning benefits which go some way to meet the learning needs of the selected group of children.

The features of the project which might have contributed to this, include

* a focus on critical and creative thinking
* the use of a problem solving approach
* a requirement for co-operative and collaborative learning
* supplying the learning tasks through an on-line computer
* offering assistance with linking the learning tasks to the on-going curriculum

- establishing a closed network of children in a similar school environment
- providing an interactive conference environment for on-line communication
- providing essential ICT training on-line for teachers to make effective use of the system supplied
- supplying a backup service to deal with teacher's specific development needs with regard to ICT (both technical and educational)
- operating, external to the school, management and control of the learning environment which was made available to the children
- supplying access, on an opt in basis, to the World Wide Web

It would be difficult to be precise about how much each of these contributed, partly because they were all elements of the general enrichment of the learning environment which the project provided. It was very much a whole 'package' where the separate parts existed less by themselves than as integral contributions to the whole operation.

In addition to the evidence detailed in the earlier sections of this report, there are other indicators of this generally enriched learning environment which was produced by the project. One striking such example was in relation to the "Insight on a Site task". A feature of this task allowed children to ask 'yes/no' questions of the natives of the Planet Argosia about some artefacts which had been discovered. The answers to these questions were to be used to help the children make some statements about their interpretation of the artefacts in terms of life on that Planet. Some 200 different questions were posed in the space of about 14 days, providing a subsequent body of information that few remote rural schools or group of children within them, might have produced by themselves.

From all the evidence discussed in this report the conclusion is that the STARS experience has been successful in making provision for meeting the learning needs of able (and other) children in a novel and stimulating manner.

In terms of successfully integrating ICT into a means of delivering relevant and effective training and development opportunities for teachers, the study has some considerable strengths in the methods selected. The STARS Project did not have a set up period where all the teachers were given prior training or development sessions. As soon as the schools had been selected by the Authorities, the teachers (who were spread over an area covering more than half of the land mass of Scotland) started their own 'learning by doing' in their own schools.

Despite a major crash of the FirstClass system lasting for over a week at the beginning of this initial period, not a single teacher gave up and during the following two months they persevered, for some barely a step ahead of the pupils. This was a trying time for many and no doubt would have been easier if the teachers had been able to come out of school for a day or so to undertake more intensive training. Because of the large geographical area involved and because of the remoteness of many of the schools, this was not an economic proposition.

Learning on-line was what had been planned and this was what took place. The training documents (some specially written) which were supplied to the schools, clearly had some success. When backed up with a 'rapid response' resolution of difficulties and supported through a self-help group with teachers who had some previous experience, the training environment was able to deliver the professional development opportunities which were intended.

From the evidence gathered and reported here, it is clear that by the end of the project, the teachers' development in ICT skills had shown considerable success. One indication of this success is provided by the requests voiced at the end of the STARS Project to be involved in any future similar projects. Every teacher said 'yes'.

This project was one of around 25 in the EDSI Programme and in common with many of them it has demonstrated its viability for promoting 'network literacy', an emerging concept which embraces pupil and teacher skills in accessing resources, creating resources and communicating with others using electronic communication technologies (DfEE, 1997a).

it has also demonstrated new relationships where young learners can effectively interact in different learning partnerships than previously. In this way the study has contributed to a developing concern that ICT is most beneficial where its potential is constantly under review.

An analysis of the technologies used in the project produced a varied picture. The problem areas included

- restrictions on small remote schools through having a single telephone line
- slow modems meant lengthy downloading times
- traditional telephone lines are not suitable for acceptable video conferencing using currently available systems
- inappropriate location of telephone points and computers for classroom learning.

The positive features were

- the hardware used was already in place in the schools and generally laid no additional financial burden on school budgets
- closed net conferencing is achievable with low cost software and is generally very robust for unsupervised pupil use
- schools using different data handling software (such as word processing) were able to send and receive attachments through FirstClass with relative ease.

The conclusion must be that for straightforward learner interaction using a networking system such as that involved in the STARS Project, it is possible and feasible to use the computing and communications facilities which currently exist in schools. Where the technology is expected to support more demanding criteria such as those associated with video conferencing, more appropriate equipment and communications facilities (such as ISDN lines) would be required.

In the case of access to the World Wide Web, there are cost implications which would seriously hamper the use of slow speed equipment and schools, particularly in small schools with limited budgets.

For Education Authorities, the issues which this project has highlighted included the competent use of available learning resources through the electronic communication media, appropriate opportunities for relevant teacher personal and professional development and effective teaching and learning in the classroom. The evidence presented in this report provides support for some progress in each of these three areas throughout the STARS Project.

Wider use of networks for learning is a good way forward, so long as the learning goals remain in prominence. Children talking with others at a distance, without a clear educational purpose, will be less appealing. Educational networks covering a wider range of schools in all sorts of arrangements from local neighbourhoods to worldwide communities is clearly an option. The STARS experience now available in a small number of Scottish rural schools may also be worth sharing directly with other relevant institutions through some form of 'cascade' effect.

The project has produced some information related to issues of compatibility of hardware and software. The Authorities might be able to make a closer examination of the existing differences as they develop their own directions for future policy.

In relation to teaching and learning, it is clear from the STARS Project that pupil interaction in the learning environment in some Scottish rural schools, is in a very healthy state.

The structure of the project promoted and enhanced for teachers as well as pupils, a constructivist approach to learning. The theoretical perspective which underpinned the project reflects a view that learning is a constructive building process embracing the approaches espoused by Piaget, Vygotsky and others (Fosnot, 1996). The evidence for social engagement and interaction as a significant stimulus for cognitive growth or enrichment (Berk and Winsler, 1995) and particularly Vygotsky's views on collaboration as a source of cognitive development (Vygotsky, 1978) significantly influenced the consistent view throughout the project that peer interaction should figure prominently in the STARS learning environment.

Mediation in learning is a central and essential aspect of the constructionist approach to learning and the STARS learning environment had regard for three roles within this; that of the teacher, the pupil and the computer. The teachers' and the pupils' roles included much of the expected interaction that takes place in the classroom which would include setting the context for a learning task; examining existing knowledge and understanding; explaining new terminology and concepts; structuring a plan for learning; accessing resources; examining and sharing ideas and suggestions; trying out new approaches; and consolidating learning outcomes.

The additional mediating roles of the teachers in the Stars Project involved their contribution to the derivation of the learning tasks and in the integrating of the STARS tasks within the ongoing curriculum of the classroom. Such integration was a key and often significant part of the teacher's workload.

The new mediating roles of the pupils was rather different from the usual classroom activity for many of them in that the sharing, collaborative element in the STARS project was carried out via electronic communication through the computer. In this respect the mediation was from a peer group not from the computer which became the vehicle to permit peer group mediation to take place. In the remote rural school, pupil-pupil mediation is often seriously restricted because of small numbers and therefore in the STARS Project (and probably not in other ongoing class work) the opportunities for interactive pupil supported learning were greatly increased.

It was seen as essential that the role of the computer would be supportive, stimulating, and complementary within the overall learning experiences provided for pupils in the small

rural school. The computer was not to be invasive, directive or in control with regard to the planning and structuring of pupil learning beyond a level which was acceptable to teachers and consistent with their own practices for using a wide range of resources for learning.

Mediation through the computer was at all times under the control of either of the teachers or the project staff. There was no automatic electronic response to pupils' learning use of the computer and the dispatch of all relevant messages was always undertaken by a member of the project staff. The provision of resources for learning in the STARS Project was wholly under the charge of the teachers or the project staff. This included providing stimulating learning material, posing problems to be solved, providing an means of interactive electronic communication with a peer group, giving answers to questions and creating an audience within which pupils could share their own learning.

The conclusion from the STARS Project was that the use of ICT for promoting learning in the classroom is effective in extending the classroom as an integrated learning environment. The use of the computer was seen an additional layer in the learning experience, contributing to the overall richness of classroom learning. The value of this form of computer network as an aid to learning lies in its ability to merge with and augment the classroom environment in the promotion of pupil autonomy in learning.

It is clear that although much independent learning may already be a part of the current small rural Primary school, work associated with the STARS Project served to further promote and enhance this approach.

Finally, from the experiences of this study, there is a limited knowledge base of a successful approach to promoting a current understanding of network literacy as it relates to education. Its future success in promoting learning in school classrooms and beyond, may lie in finding ways to promote this knowledge and the associated experience of those involved so that further progress can be made and new applications can be trialled.

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